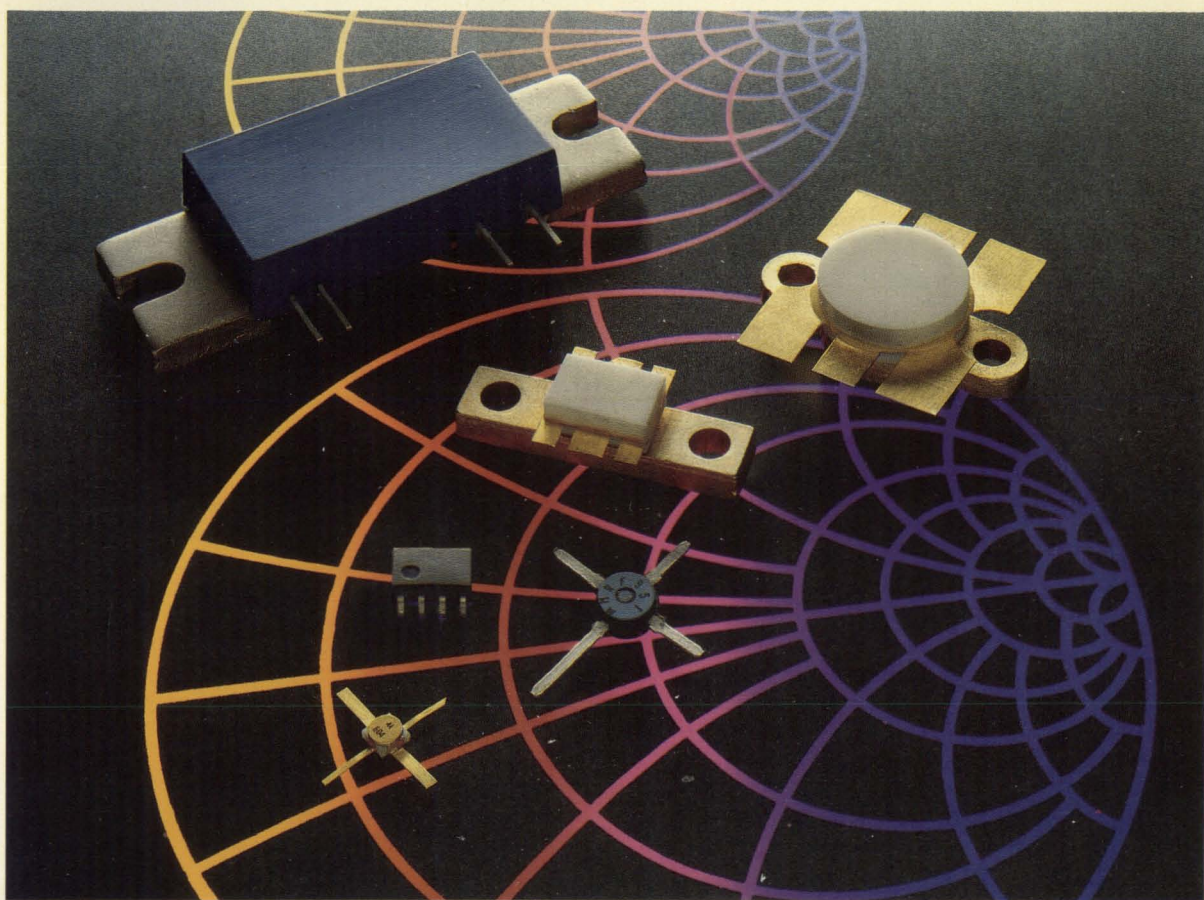




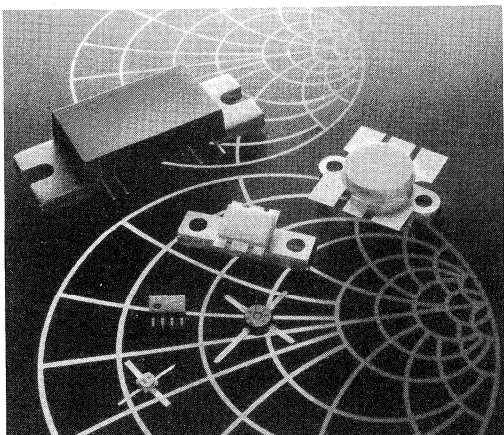
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RF DEVICE DATA

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MOTOROLA

RF DATA MANUAL

Volume I

Prepared by
Technical Information Center

Extensive changes have been made to the fifth edition of the RF Data Manual. Most important of all is the inclusion of many new products made in our Lawndale and Bordeaux facilities which were acquired by Motorola in March, 1988 (formerly the RF Devices Division of TRW).

The large increase in the number of devices, both discrete devices and amplifiers, has necessitated publishing the RF Data Manual in two volumes. We have arbitrarily decided to include all Discrete transistors in Volume 1 (along with the Discrete portion of the RF Selector Guide) and all other devices, primarily Amplifiers, in Volume 2.


Also in Volume 2 is a greatly expanded section on Applications. The many diverse Application Notes from Bordeaux and Lawndale personnel have been integrated along with the previously available Phoenix Application Notes and Engineering Bulletins to form one of the most comprehensive groups of RF application information available in the industry today.

HOW TO USE THIS RF DATA MANUAL:

Note that all devices in a given section — Discrete Transistors, Amplifiers and Tuning Diodes — are organized in conventional alphanumeric order.

If you know the part for which you desire technical data, simply turn to the appropriate page in Volume 1 or 2. If you are seeking a replacement for a competitor's part, then use the **Cross Reference** in Volume 2 to find the Motorola recommended replacement. If you have a requirement for a specified frequency band, then use the **Selector Guide** (in both Volumes 1 and 2) to find a suitable part with the desired voltage, output power, gain or other requisite characteristic.

Although information in these books has been carefully checked, no responsibility for inaccuracies can be assumed by Motorola. Please consult your nearest Motorola Semiconductor sales office for further assistance regarding any aspect of Motorola RF Products.

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DATA CLASSIFICATION

Product Preview

Data sheets herein contain information on a product under development. Motorola reserves the right to change or discontinue these products without notice.

Advanced Information

Data sheets herein contain information on new products. Specifications and information are subject to change without notice.

Formal

For a fully characterized device there must be devices in the warehouse and price authorization.

Designer's

The Designer's Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

Designer's, Epicap, MACRO-T, MACRO-X and TMOS are trademarks of Motorola Inc.

Annular Semiconductors patented by Motorola Inc.

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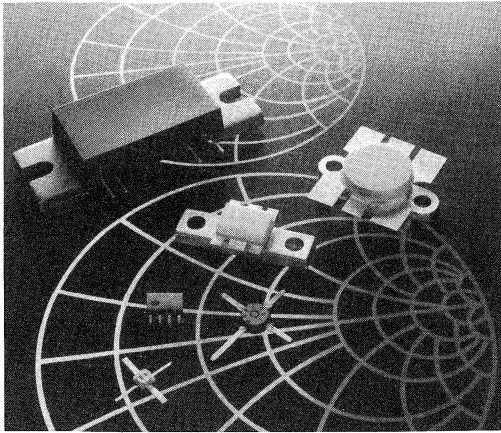
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Volume I

Selector Guide

1

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RF Power TMOS FETs

Motorola RF Power MOSFETs, (trademark TMOS), are constructed using a planar process to enhance manufacturing repeatability. They are *N-channel field effect transistors* with an oxide insulated gate which controls vertical current flow.

Compared with bipolar transistors, RF Power FETs exhibit higher gain, higher input impedance, enhanced thermal stability and lower noise. The FETs listed in this section are specified for operation in RF Power Amplifiers and are grouped by frequency range of operation and type of application. Arrangement within each group is by order of first voltage then increasing output power.

1

TO 150 MHz HF/SSB

For military and commercial HF/SSB fixed, mobile, and marine transmitters.

Device	P _{out} Output Power Watts	P _{in} Input Power Typical Watts	G _{ps} Typical Gain dB @ 30 MHz	Typical IMD		θ _{JC} °C/W	Package/Style
				d ₃ dB	d ₁₁ dB		
MRF138	30	0.6	17	-30	-60	1.5	211-07/2
MRF140	150	4.7	15	-30	-60	0.6	211-11/2

V_{DD} = 28 Volts

V_{DD} = 50 Volts

MRF148	30	0.5	18	-35	-60	1.5	211-07/2
MRF150	150	2.9	17	-32	-60	0.6	211-11/2
MRF153	300	6	17	-25	—	0.25	368-01/2
MRF154	600	12	17	-25	—	0.13	368-01/2
MRF155 (1)	300	1.9	22	-25	—	0.25	368-01/2
MRF156 (1)	600	6	20	-25	—	0.13	368-01/2

TO 225 MHz VHF AM/FM

For VHF military and commercial aircraft radio transmitters.

Device	P _{out} Output Power Watts	P _{in} Input Power Typical Watts	G _{ps} (Typ)/Freq. dB/MHz	η Typical Efficiency %	θ _{JC} °C/W	Package/Style
MRF134	5	0.2	14/150	55	10	211-07/2
MRF136	15	0.38	16/150	60	3.2	211-07/2
MRF136Y	30	1.2	14/150	54	1.8	319B-01/1
MRF137	30	0.75	16/150	60	1.8	211-07/2
MRF141 (1)	150	10	10/175	55	0.6	211-11/2
MRF141G (1)	300	13	10/175	55	0.35	375-01/2
MRF171	45	1.4	15/150	60	1.5	211-07/2
MRF172	80	4.7	12.3/150	60	0.8	211-11/2
MRF174	125	8.3	11.8/150	60	0.65	211-11/2
MRF175GV (1)	200	8	14/225	65	0.44	375-01/2
MRF175LV (1)	100	4	14/225	65	0.65	333-03/1

V_{DD} = 50 Volts

MRF151 (1)	150	7.5	13/175	45	0.6	211-11/2
MRF151G (1)	300	7.5	16/175	55	0.35	375-01/2
MRF176GV (1)	200	4	17/225	55	0.44	375-01/2

TO 500 MHz UHF AM/FM

For VHF/UHF military and commercial aircraft radio transmitters.


V_{DD} = 28 Volts

MRF158R (1)	2	0.02	20/400	55	22	79-05/7
MRF160R (1)	4	0.04	20/400	55	12	79-05/7
MRF161	5	0.4	13.5/400	45	10	244-04/3
MRF162	15	1.2	11/400	45	3.5	244-04/3
MRF163	25	2.5	10/400	45	2	244-04/3
MRF166C (1)	20	0.4	17/400	55	2.5	319-06/3
MRF175GU (1)	150	9.5	12/400	55	0.44	375-01/2
MRF175LU (1)	100	10	10/400	55	0.65	333-03/1

V_{DD} = 50 Volts

MRF176GU (1)	150	9.5	12/400	45	0.44	375-01/2
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(1) To be introduced

 New introductions

RF Power Bipolar Transistors

Motorola's broad line of bipolar RF power transistors are characterized for operation in RF power amplifiers. Typical applications are in military and commercial landmobile, avionics and marine radio transmitters. Groupings are by frequency band and type of application. Within each group, the arrangement of devices is by major supply voltage rating, then in the order of increasing output power. Details of package dimensions appear on Page 62. All devices are NPN polarity except where otherwise noted.

HF Transistors

1.5–30 MHz, HF/SSB

Designed for broadband operation, these devices feature specified Intermodulation Distortion at rated power output. Applications include mobile, marine, fixed station, and amateur HF/SSB equipment, operating from 12.5, 13.6, 28 or 50 volt supplies.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts (Max)	G _{pE} (Min) Power Gain dB @ 30 MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 12.5 or 13.6 Volts

MRF476	3 PEP/CW	0.1	15	17.5	221A-04/1
MRF475	12 PEP/CW	1.2	10	10	221A-04/1
MRF433	12.5 PEP/CW	0.125	20	8.8	211-07/1
MRF479	15 PEP/CW	0.95	12	5.9	221A-04/2
MRF406	20 PEP/CW	1.25	12	2.2	211-07/1
MRF460	40 PEP/CW	2.5	12	1	211-11/1
MRF477	40 PEP/CW	1.25	15	2	221A-04/2
MRF421	100 PEP/CW	10	10	0.6	211-11/1

V_{CC} = 28 Volts

MRF410	10 PEP/CW	0.5	13	4.4	211-07/1
MRF410A	10 PEP/CW	0.5	13	4.4	145A-09/1
MRF485	15 PEP/CW	1.5	10	3.4	221A-04/1
MRF426	25 PEP/CW	0.16	22	2.5	211-07/1
MRF401	25 PEP/CW	1.25	13	3.5	145A-09/1
MRF466	40 PEP/CW	1.25	15	1	211-07/1
MRF486	40 PEP/CW	1.25	15	2	221A-04/2
PT9784 (2)	75 PEP/CW	2.4	14.9 (3)	0.87	211-07/1
MRF464	80 PEP/CW	2.53	15	0.7	211-11/1
MRF464A	80 PEP/CW	2.53	15	0.7	145A-10/1
PT9785	100 PEP/CW	5	13 (3)	0.5	211-07/1
MRF422	150 PEP/CW	15	10	0.6	211-11/1

V_{CC} = 50 Volts

MRF427	25 PEP/CW	0.4	18	2.2	211-11/1
MRF428	150 PEP/CW	7.5	13	0.5	211-11/1
MRF429	150 PEP/CW	7.5	13	0.8	211-11/1
MRF448	250 PEP/CW	15.7	12	0.6	211-11/1
MRF430	600 PEP/CW	60	10	0.2	368-01/1

14–30 MHz, CB/AMATEUR BAND

These HF transistors are designed for economical, high-volume use in CW, AM and SSB applications.

V_{CC} = 12.5 or 13.6 Volts

MRF476	3	0.1	15	17.5	221A-04/1
MRF475	4	0.4	10	10	221A-04/1
MRF449A	30	1.9	12	2.9	145A-09/1
MRF450	50	4	11	1.5	211-07/1
MRF450A	50	4	11	1.5	145A-09/1
MRF455	60	3	13	1	211-07/1
MRF455A	60	3	13	1	145A-09/1
MRF454	80	5	12	0.7	211-11/1
MRF458	80	5	12	1	211-11/1

(2) Available in .280 SOE stud (Case 244C-01/1) by adding "A" suffix to device number

(3) Gain specified at 28 MHz

27–50 MHz, LOW-BAND FM BAND

For use in the FM "Low-Band," for Mobile communications.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts (Max)	G _{PE} (Min) Power Gain dB @ 50 MHz	θ_{JC} °C/W	Package/Style
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V_{CC} = 12.5 or 13.6 Volts

MRF475	4	0.4	10	10	221A-04/1
PT8852 (2)	20	1.5	11.2	3.5	211-07/1
PT8853 (2)	35	3.5	10	2.3	211-07/1
MRF497	40	4	10	2	221A-04/2
MRF492	70	5.6	11	0.7	211-11/1
MRF492A	70	5.6	11	0.7	145A-10/1

V_{CC} = 28 Volts

PT9783 (2)	50	2	14 (3)	1	211-07/1
PT9780	100	4	14 (3)	0.5	211-11/1

V_{CC} = 50 Volts

PT9798	75	2.4	15 (3)	1	211-07/1
PT9790	150	4.8	15 (3)	0.5	211-11/1

VHF Transistors

30–200 MHz BAND

Designed for Military Radio and Commercial Aircraft VHF bands, these 28-volt devices include the all-gold metallized MRF314/15/16/17 high-reliability series.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts (Max)	G _{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
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V_{CC} = 28 Volts

2N3553	2.5	0.25	10/175	25	79-04/1
PT9730	4	0.2	13/175	17.5	145D-01/1
2N5641	7	1	8.4/175	11.6	144B-05/1
MRF340	8	0.4	13/136	11.6	221A-04/2
PT9732	8	0.5	12/175	8.8	145D-01/1
PT9734	15	1	11.8/175	5.8	145D-01/1
2N5642	20	3	8.2/175	5.9	145A-09/1
MRF342	24	1.9	11/136	3.2	221A-04/2
PT9731	25	2.5	10/175	3.9	145D-01/1
MRF314	30	3	10/150	2.2	211-07/1
MRF314A	30	3	10/150	2.2	145A-09/1
2N5643	40	6.9	7.6/175	2.9	145A-09/1
MRF315	45	5.7	9/150	1.6	211-07/1
MRF315A	45	5.7	9/150	1.6	145A-09/1
PT9733	50	10	7/175	2.1	145D-01/1
MRF344	60	15	6/136	2	221A-04/2
MRF316 (4)	80	8	10/150	0.8	316-01/1
MRF317 (4)	100	12.5	9/150	0.65	316-01/1
JO1006 (4)	100	20	7/180	0.88	316A-01/1
TPA0102-130 (4)	130	16.4	9/180	0.5	390-01/1
TP9386	150	15	10/175	0.7	316A-01/1

(2) Available in .280 SOE stud (Case 244C-01/1) by adding "A" suffix to device number

(3) Gain specified at 28 MHz

(4) Internal Impedance Matched

66–88 MHz BAND

Power output chains up to 25 watts output are obtainable in the international VHF FM "Mid-Band" for which these transistors are optimized.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts (Max)	G _{pE} (Min) Power Gain dB/MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 7.5 Volts

TP212	1.5	0.075	13/88	10	244C-01/1
TP212S	1.5	0.075	13/88	10	249A-01/1

V_{CC} = 12.5 Volts

MRF229	1.5	0.15	10/90	35	79-05/5
MRF232	7.5	0.95	9/90	8.8	145A-09/1
PT8862 (2)	12	1.92	8.2/88	1.2	211-07/1
MRF233	15	1.5	10/90	3.5	145A-09/1
MRF234	25	2.8	9.5/90	2.5	145A-09/1
PT8864 (2)	35	4	8.9/88	2.3	211-07/1
TP2180	80	16	7/88	1.25	316A-01/1

88–108 MHz, FM BROADCAST BAND

These parts are designed for solid state transmitter applications in the FM broadcast band. They feature diffused ballast resistors and gold metallization that enhances long term reliability.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts (Max)	G _{pE} (Min) Power Gain dB/MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 28 Volts

TP9380	75	7	10.3/108	1.5	211-11/1
TP9383	150	18	9.2/108	0.75	211-11/1
TP9390	250	22.2	11/108	0.45	397-01/1

136–174 MHz HIGH BAND

The "workhorse" VHF FM High-Band is served by Motorola with the broadest range of devices and package combinations in the industry.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts (Max)	G _{pE} (Min) Power Gain dB @ 175 MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 12.5 Volts

2N4427	1	0.1	10	50	79-04/1
MRF604	1	0.1	10	91	26-03/1
MRF553	1.5	0.11	11.5	25	317D-02/2
MRF607	1.75	0.12	11.5	36	79-04/1
TP2306	2	0.15	11.2	23.5	79-04/1
TP2307	2.75	0.08	15.4	20	79-04/5
2N6080	4	0.25	12	14.6	145A-09/1
MRF220	4	0.25	12	14.6	211-07/1
MRF237	4	0.25	12	22	79-05/5
TP2300	4	0.25	12	5	145D-01/1
TP2314	4	0.25	12	20	79-04/5
MRF260	5	0.5	10	14.6	221A-04/2
TP8828	9	0.72	11	3.5	145D-01/1
TP8828F	9	0.72	11	3.5	211-07/1
MRF212	10	1.25	9	4.7	145A-09/1
MRF261	10	3	5.2	5.9	221A-04/2
2N6081	15	3.5	6.3	5.7	145A-09/1

(2) Available in .280 SOE stud (Case 244C-01/1) by adding "A" suffix to device number

(continued)

136–174 MHz, HIGH BAND (continued)

Device	P _{out} Output Power Watts	P _{in} Input Power Watts (Max)	G _{PE} (Min) Power Gain dB @ 175 MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 12.5 Volts — continued

MRF221	15	3.5	6.3	5.7	211-07/1
MRF262	15	3.5	6.3	4.7	221A-04/2
MRF2628	15	0.95	12	4	244-04/1
TP2317	20	4	7	2.2	145D-01/1
2N6082	25	6	6.2	2.7	145A-09/1
TP2325	25	6	6.2	2.2	145D-01/1
2N6083	30	8.1	5.7	2.7	145A-09/1
MRF238	30	3.7	9	2.7	145A-09/1
MRF239	30	3	10	2.7	145A-09/1
MRF264	30	9.1	5.2	2.4	221A-04/2
MRF1946	30	3	10	1.6	211-07/1
MRF1946A	30	3	10	1.8	145A-09/1
TP2330	30	3	10	2.2	145D-01/1
TP2330F	30	3.8	9	2.2	211-07/1
TP2335	35	2.8	11	2.2	145D-01/1
JO4036 (4)	36	6	7.8	1.75	316A-01/1
2N6084	40	14.3	4.5	1.8	145A-09/1
MRF224	40	14.3	4.5	2.2	211-07/1
MRF240	40	5	9	2.2	145A-09/1
MRF240A	40	5	9	2.2	211-07/1
PT8874 (2)	40	12	5.2	2.3	211-07/1
TP2304	40	12.1	5.2	2.2	145D-01/1
JO4045 (4)	45	10	6.5	1.75	316A-01/1
MRF4070 (4)	70	20	5	1.8	316-01/1
TP2370	70	21.7	5.1	1.25	145D-01/1
MRF247 (4)	75	15	7	0.7	316-01/1

225 MHz, ULTRA HIGH BAND

Specifically designed and characterized for the 225 MHz band, these devices eliminate the guesswork required when adapting 175 MHz characterized devices to this application.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts (Max)	G _{PE} (Min) Power Gain dB @ 225 MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 12.5 Volts

MRF207	1	0.15	8.2	50	79-04/1
MRF227	3	0.13	13.5	21.8	79-05/5
TP2031	3.5	0.32	10.7	20	79-04/5
MRF208	10	0.1	10	4.7	145A-09/1
TP2032	10	1.52	8.2	3.5	145D-01/1
TP2032F	10	1.52	8.2	3.5	211-07/1
MRF226	13	1.6	9	3.9	145A-09/1
TP2033	30	3.9	8.9	2.2	145D-01/1
TP2034	35	10	5.5	2.2	145D-01/1
TP2034F	35	10	5.5	2.2	211-07/1
TP2037	35	4.5	8.9	2.2	145D-01/1

(2) Available in .280 SOE stud (Case 244C-01/1) by adding "A" suffix to device number

(4) Internal Impedance Matched

UHF Transistors

100–400 MHz BAND

Stringent requirements of the UHF Military band are met by MRF325, 326, 327, 329, 2N6439 and 2N6985 types, with all-gold metal systems, specified ruggedness and programmed wirebond construction, to assure consistent input impedances for internally matched parts. Hi-Rel versions of these transistors are available upon request.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _{PE} (Min) Power Gain dB @ 400 MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 28 Volts

MRF525	0.02	0.001	13	60	79-05/5
2N3866	1	0.1	10	35	79-04/1
2N5160 (5)	1	0.16	8	35	79-04/1
PT9700	1.5	0.12	11	35	244C-01/1
MRF5174	2	0.125	12	36	244-04/1
PT9701B	5	0.63	9	17.5	244C-01/1
PT9703B	10	1.52	8.2	8.8	244C-01/1
PT9702B	20	4	7	4.4	244C-01/1
PT9704B	30	6	7	2.5	244C-01/1
MRA0204-30V (4)	30	3.8	9	2.4	316A-01/1
MRF325 (4)	30	4.3	8.5	2.2	316-01/1
MRF326 (4)	40	8	9	1.6	316-01/1
TPM4040	40	4	10	2	827-01/1
JO2015A	50	5	10	1.25	316A-01/1
MRF309 (4)	50	10	7	1.2	316-01/1
2N6439 (4)	60	10	7.8	1.2	316-01/1
MRA0204-60 (4)	60	6.75	9.5	1.25	316A-01/1
MRA0204-60V (4)	60	10	7.8	1.25	316A-01/1
MRA0204-60VH (4)	60	10	7.8	1.25	402A-01/1
MRF390 (6)	60	6.8	7.5	1.3	744A-01/1
MRA0204-70 (4)	70	10	8.5	1.2	316A-01/1
MRF327 (4)	80	14.9	7.3	0.7	316-01/1
MRF329 (4)	100	20	7	0.7	333-03/1
TPM4100	100	17.8	7.5	0.85	827-01/1
MRT0204-110V (4)	110	22	7	0.65	390-01/1
MRF392 (6)	125	19.8	8	0.7	744A-01/1
2N6985 (6)	125	19.8	8	0.7	382-01/1
TPM4130	130	24.8	7.2	0.85	827-01/1

100–500 MHz BAND

Similar to the 100–400 MHz transistors, these devices have bandwidth capabilities allowing their use to 500 MHz. All have nitride passivated die, gold metal systems, specified ruggedness and controlled wireband construction to meet the stringent requirements of military space applications. Hi-Rel versions are available upon request.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _{PE} (Min)/Freq. Power Gain dB/MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 28 V

MRF313	1	0.03	15/400	28.5	305A-01/1
MRF321	10	0.62	12/400	6.4	244-04/1
MRF323	20	2	10/400	3.2	244-04/1
MRT0105-75 (4)	75	13.4	7.5/500	0.65	390-01/1
MRT0105-75V (4)	75	15	7/500	0.7	390-01/1
MRF393 (6)	100	18	7.5/500	0.7	744A-01/1
2N6986 (6)	100	18	7.5/500	0.7	382-01/1

(4) Internal Impedance Matched

(5) PNP

(6) Internal Impedance Matched Push-Pull Transistors

500–1000 MHz BAND

Capable of operation in either class AB or C, the following device is designed for operation to 1 GHz. Gold metallized die, diffused emitter ballast resistors and a hermetic package make the MRA0510-50H suitable for industrial or military applications.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _{pE} (Min) Power Gain dB @ 1 GHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 28 Volts

MRA0510-50H	50	10	7	1.4	391-01/1
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400–512 MHz BAND

Higher power output devices in this UHF power transistor series feature internally input-matched construction, are designed for broadband operation, and have guaranteed ruggedness under output mismatch and RF overdrive conditions. Devices are specified for handheld, mobile and base station operation.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _{pE} (Min)/Freq. Power Gain dB/MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 7.5 Volts

TP251	0.2	0.01	12.4/470	60	305C-01/1
MRF750	0.5	0.05	10/470	29	305A-01/1
TP254	1.5	0.18	9.3/470	15	244C-01/1
TP254S	1.5	0.18	9.3/470	15	249A-01/1
MRF752	2.5	0.4	8/470	12	249-05/1
TP2007A	4	1.49	4.3/470	4	249A-01/1
MRF754	8	2	6/470	5	249-05/1


V_{CC} = 12.5 Volts

MRF627	0.5	0.05	10/470	28.5	305A-01/1
MRF581 (7)	0.6	0.03	13/500	40	317-01/2
MRF515	0.75	0.12	8/470	70	79-04/1
MRF555	1.5	0.15	10/470	25	317D-02/2
2N5944	2	0.25	9/470	35	244-04/1
MRF629	2	0.32	8/470	35	79-05/5
PT8809A	2	0.2	10/470	10	244C-01/1
TP2502	2	0.2	10/470	12	249A-01/1
MRF630	3	0.33	9.5/470	20	79-05/5
2N5945	4	0.64	8/470	11.7	244-04/1
MRF652	5	0.5	10/512	7	244-04/1
PT8810	5	0.7	8.5/470	5	244C-01/1
TP2503	5	0.7	8.5/470	10	249A-01/1
TP2505	5	0.7	8.5/470	5	244C-01/1
TP2505S	5	0.7	8.5/470	5	249A-01/1
MRF660	7	2	5.4/470	7	221A-04/2
2N5946	10	2.5	6/470	4.7	244-04/1
MRF653	10	2	7/512	4	244-04/1
PT8811A	10	2.5	6/470	35	244C-01/1
TP2510	10	2.5	6/470	3.5	244C-01/1
TP2511	10	1	10/470	3.5	319C-01/2
MRF641 (4)	15	2.5	7.8/470	4	316-01/1
MRF654 (4)	15	2.5	7.8/470	4	244-04/1
TP2520	20	2	10/470	3.5	828-01/1
MRF644 (4)	25	5.9	6.2/470	1.7	316-01/1
JO3037 (4)	37	12	4.9/512	2.1	316A-01/1
MRF646 (4)	40	13.3	4.8/470	1.5	316-01/1
MRF648 (4)	60	22	4.4/470	1	316-01/1
MRF650 (4) (1)	50	11.7	6.3/470	0.9	316-01/1

(1) To be introduced

(4) Internal Impedance Matched

(7) Small signal gain. P_O is Typ.

 New introductions

400–512 MHz BAND (continued)

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _p (Min)/Freq. Power Gain dB/MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 23 Volts

JO2017 (4)	60	12	7/440	0.7	316A-01/1
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V_{CC} = 24 Volts

TP5002	1.5	0.075	13/470	21	244C-01/1
TP5002S	1.5	0.075	13/470	21	249A-01/1
TP5015	15	1.34	11/470	7	319C-01/2
TP5040	40	5	9/470	2	395-01/1
TP5060	50	12.5	6/470	0.7	827-01/1

V_{CC} = 28 Volts

TP5050	50	6.25	9/470	1.5	316A-01/1
TP5060	60	17	5.5/470	0.7	827-01/1
MRF338	80	15	7.3/470	0.7	333-03/1

800 MHz Transistors

806–960 MHz BAND

Designed specifically for the 800 MHz mobile radio band, types MRF840 through 847 offer superior gain and ruggedness, using the unique CS-12 package, which minimizes common-element impedance, and thus maximizes gain and stability. Devices are listed for mobile and base station applications.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _p (Min)/Freq. Power Gain dB/MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 9.6 Volts

TP301	0.8	0.9	9.5/900	24	305B-01/1
TP301S	0.8	0.9	9.5/900	24	305C-01/1
TP302	2	0.36	7.5/900	12	305B-01/1
TP302S	2	0.36	7.5/900	12	305C-01/1
TP303	3	0.6	7/900	9	305B-01/1
TP303S	3	0.6	7/900	9	305C-01/1
TP304	5	1.25	6/900	6	244C-01/1
TP304S	5	1.25	6/900	6	249A-01/1

V_{CC} = 12.5 Volts

MRF559	0.5	0.08	8/870	50	317-01/2
MRF581	0.6	0.06	10/870	40	317-01/2
MRF837	0.75	0.11	8/870	40	317-01/1
MRF8372	0.75	0.11	8/870	45	751-02/1
TP3009	0.75	0.14	7.5/900	26	305B-01/1
TP3009S	0.75	0.14	7.5/900	26	305C-01/1
MRF838	1	0.22	6.5/870	70	305A-01/1
MRF838A	1	0.22	6.5/870	70	305-01/1
MRF557	1.5	0.23	8/870	25	317D-02/2
TP3010	1.5	0.3	7/900	14	305B-01/1
TP3010S	1.5	0.3	7/900	14	305C-01/1
MRF839	3	0.46	8/870	9	305A-01/1
MRF839F	3	0.46	8/870	9	319-06/2
TP3011	4	0.8	7/900	8	244C-01/1

(4) Internal Impedance Matched

(continued)

806–960 MHz BAND (continued)

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _p (Min)/Freq. Power Gain dB/MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 12.5 Volts — continued

TP3011S	4	0.8	7/900	8	249A-01/1
TP3013	4	0.71	7.5/900	7	319C-01/2
MRF841F	5	0.7	8.5/870	7	319-06/1
MRF840 (4)	10	2.5	6/870	3.1	319-06/1
TP3012	10	2	7/900	4	319C-01/2
MRF843 (4)	15	3	7/870	4	244-04/4
MRF843F (4)	15	3	7/870	4	319-06/1
MRF873 (4)	15	3	7	4	319-06/1
MRF842 (4)	20	5	6/870	1.5	319-06/1
MRF844 (4)	30	9	5.2/870	1.5	319-06/1
MRF846 (4)	40	15	4.3/870	1.2	319-06/1
MRF847 (4)	45	16	4.5/870	1	319-06-1

V_{CC} = 24 Volts

MRF890	2	0.25	9/900	25	305-01/1
PTE801	2	0.25	9/960	22	305B-01/1
TP3023	4	0.5	9/960 (8)	7	244C-01/1
MRF891	5	0.63	9/900	7	319-06/2
MRF892 (4)	14	2	8.5/900	3.5	319-06/1
JO3501 (4)	15	1.5	10/960	4.6	828-01/1
TP3026	25	4	8/960 (8)	2.5	319C-01/2
MRF894 (4)	30	6	7/900	1.5	319-06/1
JO3502 (4)	35	5.95	7.7/960	2.3	319C-01/1
TP3040	40	6.4	8/960 (8)	1.8	319C-01/2
MRF898 (4)	60	12	7/900	1	333A-02/1

V_{CC} = 26 Volts

TP3020A	2.2	0.28	9/960	20	244C-01/1
TP3022A	15	2.12	8.5/960	6	319C-01/2
TP3024A	35.5	6.35	7.5/960	3	395-01/1

Microwave Transistors

L-BAND PULSE POWER


These products are designed to operate in short pulse width, 10 μs, low duty cycle, 1%, power amplifiers operating in the 960 to 1215 MHz band. All devices have internal impedance matching. The prime application is avionics equipment for distance measuring (DME), area navigation (TACAN) and interrogation (IFF). All devices offered with hermetic option.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _p (Min) Power Gain dB @ 1090 MHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 18 Volts — Class A & AB Common Emitter

MRF1000MA	0.2	0.02	10	25	332-04/2
MRF1000MB	0.2	0.02	10	25	332A-01/2
MRF1000MC	0.2	0.02	10	25	361A-01/2

(4) Internal Impedance Matched
(8) Class AB

 New introductions

1

L-BAND PULSE POWER (continued)

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _p (Min) Power Gain dB @ 1090 MHz	θ_{JC} °C/W	Package/Style
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V_{CC} = 35 Volts — Class B & C Common Base

MRF1002MA	2	0.2	10	25	332-04/1
MRF1002MB	2	0.2	10	25	332A-01/1
MRF1002MC	2	0.2	10	25	361A-01/1
MRF1004MA	4	0.4	10	25	332-04/1
MRF1004MB	4	0.4	10	25	332A-01/1
MRF1004MC	4	0.4	10	25	361A-01/1
MRF1008MA	8	0.8	10	15	332-04/1
MRF1008MB	8	0.8	10	15	332A-01/1
MRF1008MC	8	0.8	10	15	361A-01/1

V_{CC} = 50 Volts — Class C Common Base

MRF1015MA	15	1.5	10	10	332-04/1
MRF1015MB	15	1.5	10	10	332A-01/1
MRF1015MC	15	1.5	10	10	361A-01/1
MRF1035MA	35	3.5	10	5	332-04/1
MRF1035MB	35	3.5	10	5	332A-01/1
MRF1035MC	35	3.5	10	5	361A-01/1
MRF1090MA	90	9	10	0.6	332-04/1
MRF1090MB	90	9	10	0.6	332A-01/1
MRF1090MC	90	9	10	0.6	361A-01/1
MRF1150M	150	25	7.8	0.3	336-03/2
MRF1150MA	150	25	7.8	0.3	332-04/1
MRF1150MB	150	25	7.8	0.3	332A-01/1
MRF1150MC	150	25	7.8	0.3	361A-01/1
MRF1250M	250	63	6	0.15	336-03/2
MRF1325M	325	81	6	0.15	336-03/2

L-BAND LONG PULSE POWER

These products are designed for pulse power amplifier applications in the 960 to 1215 MHz frequency range. They are capable of handling up to 10 μ s pulses in long pulse trains resulting in up to a 50% duty cycle over a 3.5 millisecond interval. Overall duty cycle is limited to 25% maximum. The primary applications for devices of this type are military systems, specifically JTIDS and commercial systems, specifically Mode S. Package type is hermetic.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _{pb} (Min) Power Gain dB @ 1215 MHz	θ_{JC} °C/W	Package/Style
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V_{CC} = 28 Volts — Class C Common Base

MRF10005	5	0.71	8.5	8	336E-02/1
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V_{CC} = 36 Volts — Class C Common Base

MRF10030	30	11.2	9.5	3	376A-01/1
MRF10120 (1)	120	19	8	0.6	376A-01/1

(1) To be introduced

 New introductions

1.7–2.3 GHz BROADBAND CW

The MRF2000M Series of transistors have internal input impedance matching networks which facilitate broadband circuit designs in the 1.7 to 2.3 GHz telecommunications band.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _{PB} (Min) Power Gain dB @ 2 GHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 24 Volts — Class B & C Common Base

MRF2001M	1	0.14	8.5	25	337-02/1
MRF2003M	3	0.48	8	16	337-02/1
MRF2005M	5	0.89	7.5	8	337-02/1
MRF2010M	10	2	7	5	337-02/1
MRF2016M	16	3.6	6.5	3.5	337-02/1

2 GHz NARROWBAND CW

The MRF2000 Series of NPN Silicon microwave power transistors are designed for common base service in amplifier or oscillator applications in the 1 to 2.3 GHz frequency range.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _{PB} (Min) Power Gain dB @ 2 GHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 28 Volts — Class B & C Common Base

MRF2001	1	0.13	9	25	328A-01/1
MRF2001B	1	0.13	9	25	328-02/1
TRW2001 (9)	1	0.13	9	35	328F-01/2
MRF2003	3	0.5	7.8	15	328A-01/1
MRF2003B	3	0.5	7.8	15	328-02/1
TRW2003 (9)	3	0.48	8	15	328F-01/2
MRF2005	5	0.8	8	7	328A-01/1
MRF2005B	5	0.8	8	7	328-02/1
TRW2005 (9)	5	0.8	8	8.5	328F-01/2
MRF2010	10	2.5	6	5	328A-01/1
MRF2010B	10	2.5	6	5	328-02/1
TRW2010 (9)	10	2	7	6	328F-01/2
TRW2015 (9)	15	3.8	6	3.5	393-01/1
TRW2020 (9)	20	6	5.2	3	393-01/1

2.3 GHz NARROWBAND CW

The TRW2300 Series are common-base configured transistors in hermetic packages with guaranteed performance characteristics at 2.3 GHz. They feature diffused ballast resistors and gold metallization for extreme ruggedness and reliability. All are available with TX equivalent screening.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	G _{PB} (Min) Power Gain dB @ 2.3 GHz	θ _{JC} °C/W	Package/Style
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V_{CC} = 20 Volts

TRW2301	1.5	0.24	8	35	328F-01/2
TRW2304	4	0.64	8	17	328F-01/2
TRW2307	7	1	8.5	8.5	328F-01/2

(9) Available in flangeless package by placing suffix "F" after device number

3 GHz NARROWBAND CW

The TRW3000 Series are the industry's first 100% VSWR tolerant 3 GHz devices. They are common-base configured in hermetic packages (with or without flanges) and rated for 28 volt operation.

Device	P _{out} Output Power Watts	P _{in} Input Power Watts	GPB (Min) Power Gain dB @ 3 GHz	θ_{JC} °C/W	Package/Style
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V_{CC} = 28 Volts

TRW3001	1	0.2	7	35	328F-01/2
TRW3003	3	0.75	6	17	328F-01/2
TRW3005	5	1.6	5	8.5	328F-01/2

0.6–2.7 GHz BROADBAND COMMON BASE

The MicRoAmp transistor employs MOS capacitors and other matching elements to transform the input, and in some devices, the output impedance to a more manageable level prior to the point where package parasitics can reduce the bandwidth capability (U.S. Patent 3,713,006). These devices are assembled in common-base configuration and include an all-gold metal system and diffused ballast resistors for long life. Those epoxy-sealed devices followed by Note 10 are also available in hermetic packages and TX equivalent.

Device	Instantaneous Frequency Range F _L -F _H (MHz)	Min Output Power Watts	Min Gain dB	θ_{JF} °C/W	Package/Style
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V_{CC} = 22 V

MRAL1417-2	1400–1700	2	8	15	394-01/1
MRAL1417-6	1400–1700	6	7.4	8	394-01/1
MRAL1417-11	1400–1700	11	7.4	4.5	394-01/1
MRAL1417-25	1400–1700	25	7	2.5	394-01/1
MRAL1720-2	1700–2000	2	7.5	15	394-01/1
MRAL1720-5	1700–2000	5	6.5	8	394-01/1
MRAL1720-9	1700–2000	9	6.5	4.5	394-01/1
MRAL1720-20	1700–2000	20	6	2.5	394-01/1
MRAL2023-1.5 (10)	2000–2300	1.5	8	30	394-01/1
MRAL2023-3 (10)	2000–2300	3	8	16	394-01/1
MRAL2023-6 (10)	2000–2300	6	6.8	8	394-01/1
MRAL2023-12 (10)	2000–2300	12	6.8	4.5	394-01/1
MRAL2023-18 (10)	2000–2300	18	6.5	2.5	394-01/1
MRAL2327-1.3	2300–2700	1.3	5.5	30	394-01/1
MRAL2327-3	2300–2700	3	6.6	16	394-01/1
MRAL2327-6	2300–2700	6	7	8	394-01/1
MRAL2327-12	2300–2700	12	6.8	4.5	394-01/1

V_{CC} = 28 Volts

MRA0610-3 (10)	600–1000	3	7.8	15	394-01/1
MRA0610-9 (10)	600–1000	9	7.8	6	394-01/1
MRA0610-18A (10)	600–1000	18	7.8	4	394-01/1
MRA0610-40A	600–1000	40	7	2.5	394-01/1
MRA1014-2 (10)	1000–1400	2	8.2	15	394-01/1
MRA1014-6 (10)	1000–1400	6	7.4	8	394-01/1
MRA1014-12 (10)	1000–1400	12	7.8	4.5	394-01/1
MRA1014-35	1000–1400	35	7	2.5	394-01/1
MRA1214-55H	1200–1400	50	6.5	1.4	402-01/1
MRA1417-2(10)	1400–1700	2	8	15	394-01/1
MRA1417-6(10)	1400–1700	6	7.4	8	394-01/1
MRA1417-11(10)	1400–1700	11	7.4	4.5	394-01/1
MRA1417-25A	1400–1700	25	7	2.5	394-01/1
MRA1720-2	1700–2000	2	7.5	15	394-01/1

(10) Hermetic package Case 393-01/1 is available by placing suffix "H" after device number

(continued)

0.6–2.7 GHz BROADBAND COMMON BASE (continued)

Device	Instantaneous Frequency Range F _L –F _H (MHz)	Min Output Power Watts	Min Gain dB	θ _{JF} °C/W	Package/Style
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V_{CC} = 28 Volts — continued

MRA1720-5	1700–2000	5	6.5	8	394-01/1
MRA1720-9	1700–2000	9	6.5	4.5	394-01/1
MRA1720-20	1700–2000	20	6	2.5	394-01/1

POWER OSCILLATORS

These oscillator devices are common collector configuration with diffused ballast resistors, gold metallization and hermetic packages to provide high reliability in severe environmental conditions. Each is fully characterized for power oscillator applications.

Device	Operating Conditions V _{CE} /I _C V/mA	Output Power — Watts/@ Freq. — GHz				Package/Style
		Minimum	Typ @ Low F	Typ @ Mid F	Typ @ High F	
TRW62601	20/220	1.25/2	1.85/2.5	1.35/2	0.85/3	328F-01/3
TRW62602	20/440	2.5/2	2.5/2	2/2.5	1.3/3	328F-01/3
TRW63601	20/120	0.6/2.3	0.75/2.3	0.5/2.8	0.28/3.3	328F-01/3
TRW63602	20/230	1.2/2.3	1.5/2.3	1/2.8	0.55/3.3	328F-01/3
TRW64601	20/120	0.3/4	0.55/3	0.35/4	0.15/5	328F-01/3
TRW64602	20/240	0.55/4	1.2/3	0.65/4	0.15/5	328F-01/3

Linear Transistors

The following sections describe a wide variety of devices specifically characterized for linear amplification. Included are low power and high power parts covering frequencies from 100 MHz to 4 GHz.

TO 1 GHz, CLASS A

These devices offer a selection of performance and price for linear amplification to 1 GHz. The "MRA" prefix parts are input matched and feature high overdrive and extreme ruggedness capability.

Device	P _O @ 1 dB Comp. Point Watts	GSS (Min) Freq. Small Signal Gain dB MHz	Bias Point (V _{dc} /A)	θ _{JC} °C/W	Package/Style
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V_{CC} = 19 Volts

MRA1000-3.5L	3.5	10/1000	19/0.6	8	145D-01/1
MRA1000-7L	7	9/1000	19/1.2	4	145D-01/1
MRA1000-14L	14	8/1000	19/2.4	2.1	145D-01/1
MRA0500-19L	19	8/500	19/3.5	1.5	145D-01/1

V_{CC} = 25 Volts

RF1029	1.5	8/1000	—	12	244A-01/1
RF1030	3	7.5/1000	—	6	244A-01/1
RF1031	4.5	7/1000	—	3.5	244A-01/1
RF1032	6	6.5/1000	—	3.5	244A-01/1

VHF ULTRA LINEAR FOR TV APPLICATIONS

The following devices have been characterized for ultra-linear applications such as low-power TV transmitters in Band III. Each features diffused ballast resistors and an all-gold metal system to provide enhanced reliability and ruggedness.

Device	P _o Watts	Gp (Min)/Freq. Power Gain dB/MHz	3 Tone IMD dB	θ _{JC} °C/W	Package/Style
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V_{CC} = 28 Volts

TPV394A	5	15/225	-58	2.5	244C-01/1
TPV364	10	10/225	-54	2	145D-01/1
TPV385	14	14/225	-53	1.5	316A-01/1
TPV375	20	8/225	-51	1.5	211-11/1
TPV387 (34)	90	12/225	dB Comp.	1	316A-01/1
TPV376	30	7.5/225	-53	1	316A-01/1
TPV3100 (34)	28	14/225	dB Comp.	0.8	827-01/1

V_{CC} = 32 Volts

TPV3250B	230	11/230	dB Comp.	0.55	397-01/1
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UHF ULTRA LINEAR FOR TV APPLICATIONS

The following devices have been characterized for ultra-linear applications such as low-power TV transmitters in Band IV and V. Each features diffused ballast resistors and an all-gold metal system to provide enhanced reliability and ruggedness.

Device	P _o @ 1 dB Comp. Point Watts	Gp (Min)/Freq. Power Gain dB/MHz	3 Tone IMD dB	θ _{JC} °C/W	Package/Style
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V_{CC} = 20 Volts

TPV590	0.25	14/860	-58	30	305B-01/1
TPV591	0.5	13/860	-58	16	305B-01/1
TPV596	0.5	11.5/860	-58	20	244C-01/1
TPV597	1	10.5/860	-58	9	244C-01/1
TPV598	4	7/860	-60	5	244C-01/1

V_{CC} = 25 Volts

TPV693	1.8	9.5/860	-60	8	224C-01/1
TPV593	2	8.5/860	-60	11	224C-01/1
TPV698	4	8.5/860	-54	6.2	224C-01/1
TPV657	6	8/860	-58	2.5	827-01/1
TPV595A	14	8.5/860	-47	2.5	395-01/1
TPV695A	14	9.5/860	-47	2.5	395-01/1
TPV7025	25	8.5/860	-45	1.5	398-01/1

V_{CC} = 26 Volts

TPV695B	30	8.5/860	dB Comp.	2.5	395-01/1
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V_{CC} = 28 Volts

TPV5051	50	6.5/860	dB Comp.	1.8	395-01/1
TPV5055B	50	7/860	dB Comp.	1.5	398-01/1
TPV6080B	80	7/860	dB Comp.	0.7	397-01/1

(34) Device listed with alternate specifications

MICROWAVE LINEAR POWER

Common emitter microwave devices are offered for a wide variety of uses in small and medium signal, Class A, AB and C applications up to 4 GHz. The use of all-gold metal systems, diffused ballast resistors and hermetic packaging results in devices that display excellent reliability even in military environment. Many part types are available with off-the-shelf TX equivalent screening.

Device	GSS (Min) Freq. Small Signal Gain dB/GHz	1 dB Comp. Watts	P _{sat} Watts	-30 dB IMD Watts	Emitter Current mA	Package/Style
TRW52001	6/2	1.8	2.5	1.5	220	400-01/1
TRW52101	6/2	1.8	2.5	1.5	220	328E-01/2
TRW52201	5/2	1.8	2.5	1.5	220	401A-01/1
TRW52401	5/2	1.8	2.5	1.5	220	328G-01/1
TRW52501 (11)	5/2	1.8	2.5	1.5	220	401-01/1
TRW52601 (11)	6/2	1.8	2.5	1.5	220	328F-01/1
TRW52102	6/2	3.6	5	3	440	328E-01/2
TRW52202	5/2	3.6	5	3	440	401A-01/1
TRW52402	5/2	3.6	5	3	440	328G-01/1
TRW52502 (11)	5/2	3.6	5	3	440	401-01/1
TRW52602	6/2	3.6	5	3	440	328F-01/1
TRW52104	5/2	7.2	10	6	880	328E-01/2
TRW52204	5/2	7.2	10	6	880	401A-01/1
TRW52504	5/2	7.2	10	6	880	401-01/1
TRW52604 (11)	5/2	7.2	10	6	880	328F-01/1
TRW53001	6/3	0.8	1	0.8	120	400-01/1
TRW53101	6/3	0.8	1	0.8	120	328E-01/2
TRW53201	5/3	0.8	1	0.8	120	401A-01/1
TRW53401	5/3	0.8	1	0.8	120	328G-01/1
TRW53501 (11)	5/3	0.8	1	0.8	120	401-01/1
TRW53601 (11)	6/3	0.8	1	0.8	120	328F-01/1
TRW53102	6/3	1.6	2	1.5	230	328E-01/2
TRW53202	5/3	1.6	2	1.5	230	401A-01/1
TRW53402	5/3	1.6	2	1.5	230	328G-01/1
TRW53502	5/3	1.6	2	1.5	230	401-01/1
TRW53602 (11)	5/3	1.6	2	1.5	230	328F-01/1
TRW53505	5/3	4	5	4	600	401-01/1
TRW53605	6/3	4	5	4	600	328F-01/1
TRW54001	5/4	0.5	0.8	0.5	120	400-01/1
TRW54101	6/4	0.5	0.8	0.5	120	328E-01/2
TRW54201	5/4	0.5	0.8	0.5	120	401A-01/1
TRW54501 (11)	5/4	0.5	0.8	0.5	120	401-01/1
TRW54601 (11)	6/4	0.5	0.8	0.5	120	328F-01/1

(11) Available in JTX equivalent by replacing "TRW" with "TX" prefix

BIAS DEVICES

The BT500 and BT500F bias devices are used to provide the proper bias point for Class AB linear amplifiers. They feature excellent thermal tracking and simple external circuitry. The BT500 is a hermetic, metal sealed device.

Device	I _F Typ mA	h _{FE} Typ	V _{(BR)EBO} Min V	Package/Style
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Bias Devices for Class AB 28-50 Volt Transistors

BT500	400-500	20-80	4	036-03/1
BT500F	400-500	20-80	4	211-07/1

(11) Available in JTX equivalent by replacing "TRW" with "TX" prefix

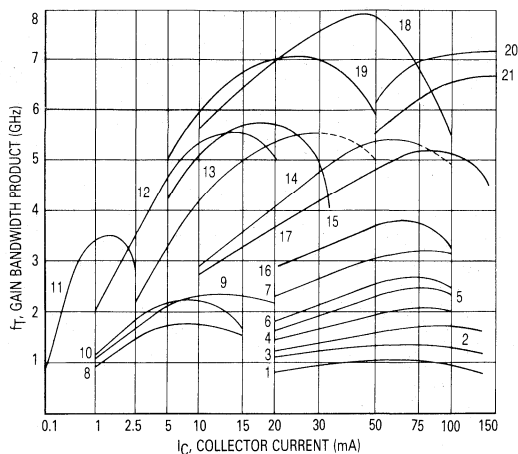
RF Small-Signal Bipolar Transistors

RF Small-Signal Transistor Gain Characteristics

Curve numbers apply to transistors listed in the subsequent tables.

Selection by Package


In small-signal RF applications, the package style is often determined by the end application or circuit construction technique. To aid the circuit designer in device selection, the Motorola broad range of RF small-signal amplifier transistors is organized by package. Devices for other applications such as oscillators or switches are shown in the appropriate preceding tables. **These devices are NPN polarity unless otherwise designated.**




PLASTIC SOE CASE

Device	Gain-Bandwidth		Curve No. Page 36	Noise Figure		Gain		Maximum Ratings			Package
	f_T GHz Typ	@ I_C mA		NF dB Typ	@ f MHz	dB Typ	@ f MHz	$V_{(BR)CEO}$ Volts	I_C mA	P_T mW	

Case 29-04/2, TO-226AA

MPS536 (5)	5	20	19	4.5	500	14	500	10	30	625	
MPS571	6	50	18	2	500	14	500	10	80	625	
MPS901	4.5	15	12	2.5	900	12	900	15	30	625	
MPS911	7	30	13	1.7	500	16.5	500	12	40	625	
MPS3866	0.8	50	1	—	—	10	400	30	400	625	

Case 317-01/2 — MACRO-X

MRF521 (5)	4.2	50	—	2.8	1000	11	1000	10	70	750	
MRF536 (5)	6	20	19	4.5	1000	10	1000	10	30	300	
MRF559	3	100	16	—	—	13	512	18	150	2000	
MRF571	8	50	18	1.5	1000	12	1000	10	70	1000	
MRF581	5	75	17	2	500	15.5	500	18	200	2500	
MRF581A	5	75	17	1.8	500	15.5	500	15	200	2500	
MRF837	5	75	17	2	500	10	870	16	200	2500	
MRF901	4.5	15	12	2	1000	12	1000	15	30	375	
MRF911	5	30	13	2.5	1000	12.5	1000	12	40	400	
MRF931	3	1	11	3.8	500	16	500	5	5	50	
MRF941	8	15	—	1.7	2000	12.5	2000	10	50	—	
MRF951	7.5	30	—	1.7	2000	12.5	2000	10	100	—	
MRF961	4.5	50	14	2	500	15	500	15	100	500	
MRF2369	6	40	18	1.5	1000	12	1000	15	70	750	


(5) PNP

(continued)


PLASTIC SOE CASE (continued)

Device	Gain-Bandwidth		Curve No. Page 36	Noise Figure		Gain		Maximum Ratings			Package
	f _T GHz Typ	@ I _C mA		NF dB Typ	@ f MHz	dB Typ	@ f MHz	V _(BR) CEO Volts	I _C mA	P _T mW	


Case 317A-01/2 — MACRO-T — continued

BFR90	5	14	12	2.4	500	18	500	15	30	180	
BFR91	5	30	13	1.9	500	16	500	12	35	180	
BFR96	4.5	50	14	2	500	14.5	500	15	100	500	
BFW92A	4.5	10	15	2.7	500	16	500	15	35	180	
MRF580	5	75	17	2	500	14	500	18	200	2500	
MRF580A	5	75	17	1.8	500	14	500	15	200	2500	


Case 317D-01/2,3

MRF542 (12)	—	—	2	—	—	5.5	250	70	400	3000	
MRF543 (5) (12)	—	—	2	—	—	5.5	250	70	400	3000	
MRF553	—	—	—	—	—	13	175	16	500	3000	
MRF555	—	—	—	—	—	12.5	470	16	400	3000	
MRF557	—	—	—	—	—	9	870	16	400	3000	

Case 318-05/6 — SOT-23

BFR93	3	30	—	2.5	30	—	—	12	35	350	
MMBR536 (5)	5.5	20	19	4.5	500	14	500	10	30	350	
MMBR571	8	50	18	2	500	16.5	500	10	80	350	
MMBR901	4	15	12	1.9	1000	16	1000	15	30	350	
MMBR911	6	30	13	2	500	17	500	12	40	350	
MMBR920	4.5	14	—	2.4	500	15	500	15	35	350	
MMBR930	5.5	30	—	1.9	500	11	500	12	35	350	
MMBR941	8	15	—	1.7	2000	12.5	2000	10	50	—	
MMBR951	7.5	30	—	1.7	2000	12.5	2000	10	100	—	
MMBR931	3.5	1	11	4.3	1000	10	1000	5	5	350	
MMBR4957 (5)	2	2	10	3	450	17	450	30	30	350	
MMBR5031	2	5	—	1.9	450	17	450	10	20	350	
MMBR5179	1.5	5	8	4	450	11	450	12	50	350	

Case 318A-04/1, Case 318B-03/1 — SOT-143

MRF0211,L	5.5	40	18	1.8	1000	13	1000	15	70	580	
MRF5211,L (5)	4.2	50	—	2.8	1000	11	1000	10	70	580	
MRF5711,L	7.5	50	18	1.6	1000	13.5	1000	10	70	580	
MRF9011,L	3.8	15	12	2.3	1000	10.2	1000	15	30	300	
MRF9331,L	5	1	—	2.5	1000	12.5	1000	8	1	50	
MRF9411,L	8	15	—	1.7	2000	12.5	2000	10	50	—	
MRF9511,L	7.5	30	—	1.7	2000	12.5	2000	10	100	—	

(5) PNP

(12) Common Base Configuration




New introductions

PLASTIC SOE CASE (continued)


Device	Gain-Bandwidth		Curve No. Page 36	Noise Figure		Gain		Maximum Ratings			Package
	f _T GHz Typ	^a I _C mA		NF dB Typ	^a f MHz	dB Typ	^a f MHz	V _(BR) CEO Volts	I _C mA	P _T mW	

Case 751-02/1 — SO-8


MRF3866	0.8	50	1	—	—	10.5	400	30	400	1000	
MRF4427	0.8	50	1	—	—	12	175	20	400	1000	
MRF5160 (5)	0.8	50	1	—	—	8	400	40	400	1000	
MRF5583 (5)	2.1	35	5	—	—	12.5	250	30	500	1000	
MRF5812	5	75	17	1.8	500	16	500	15	200	1500	
MRF5943	1.55	35	4	3.4	200	12	250	30	400	1000	
MRF8372	5	75	17	2	500	10	870	16	200	1500	
MRFQ17	2.2	50	5	—	—	12	500	25	300	1000	
MRFQ19	5.5	75	14	3.5	500	14.5	500	15	150	1000	

CERAMIC SOE CASE


Case 144D-06/1

2N5947	1.5	75	3	3.8	200	11	250	30	400	5000	
MRF511	2.1	80	7	7.3	200	11	250	25	250	5000	


Case 244A-01/1,3

LT2001	3	90	7	2.5	300	11.5	300	20	200	5000	
LT5217 (5)	4	90	—	4	500	11	500	15	300	5000	
MRF546 (12)	—	—	—	—	—	6	250	70	600	9000	
MRF547 (12) (5)	—	—	—	—	—	5.5	250	70	600	9000	
MRF548 (12)	—	—	2	—	—	5.5	250	70	400	5000	
MRF549 (12) (5)	—	—	2	—	—	5.5	250	70	400	5000	
MRF587	5.5	90	17	3	500	13	500	17	200	5000	
PT4572A	2.5	90	6	2.3	300	14	300	25	200	5000	


Case 244C-01/1

TP3401	5	150	—	—	—	14	500	13	200	4300	
TP3402	5	300	—	—	—	10.5	500	13	400	9500	

Case 244D-01/1

LT4217	5.5	90	—	2.5	500	15	500	12	400	5000	
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Case 249A-01/1

TP3401S	5	150	—	—	—	14	500	13	200	4300	
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(5) PNP

(12) Common Base Configuration




New introductions


CERAMIC SOE CASE (continued)

Device	Gain-Bandwidth		Curve No. Page 36	Noise Figure		Gain		Maximum Ratings			Package
	f _T GHz Typ	I _C mA		NF dB Max	f MHz	dB Min	f MHz	V _(BR) CEO Volts	I _C mA	P _T mW	


Case 303-01/1

2N6603	5.5	15	12	2	1000	13	1000	15	30	400	
2N6604	5.5	30	13	2.7	1000	12	1000	15	50	500	
2N6618	—	—	—	2.2	2000	11	2000	20	20	300	
2N6679	(f _T dB is 18.5 dBm Typ @ 4 GHz)					9	4000	20	70	900	
LT4700	6	25	19	3	2000	10	2000	12	50	750	
MRF942	8	15	—	1.7	2000	12.5	2000	10	50	—	
MRF952	7.5	30	—	1.7	2000	12.5	2000	10	100	—	
MRF522 (5)	4.2	50	—	2.8	1000	11	1000	10	50	620	
MRF572	8	50	18	1.5	1000	12	1000	10	70	750	
MRF962	4.5	50	14	2	500	16.5	500	15	100	750	


Case 305B-01/1

LT3005	3	90	7	2.5	300	14	300	20	200	5000	
TP3400	3	125	—	7	500	14.5	860	20	400	5000	

Case 358-01/1


MRF573	8	50	18	2	1000	10	1000	10	70	750	
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Case 401-01/1


LT3014	3	90	7	3.1	300	14	500	20	200	5000	
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METAL CAN

Case 20-03/10, TO-206AF

2N2857	1.6	8	8	4.5	450	12.5	450	15	40	200	
2N4957 (5)	1.6	2	10	3	450	17	450	30	30	200	
2N4958 (5)	1.5	2	10	3.3	450	16	450	30	30	200	
2N4959 (5)	1.5	2	10	3.8	450	15	450	30	30	200	
2N5031	1.6	5	8	2.5	450	14	450	10	20	200	
2N5032	1.5	5	8	3	450	14	450	10	20	200	
2N5179	1.4	10	8	4.5	200	15	200	12	50	200	
2N6304	1.8	10	9	4.5	450	15	450	15	50	200	
2N6305	1.8	10	9	5.5	450	12	450	15	50	200	
BFR99 (5)	1.7	10	9	6	800	—	—	25	50	225	
BFX89	1.6	25	9	6.5	500	19	200	15	50	200	

(5) PNP


 New introductions

SELECTION BY PACKAGE (continued)


METAL CAN (continued)

Device	Gain-Bandwidth		Curve No. Page 36	Noise Figure		Gain		Maximum Ratings			Package
	f _T GHz Typ	@ I _C mA		NF dB Max	@ f MHz	dB Min	@ f MHz	V _(BR) CEO Volts	I _C mA	P _T mW	


Case 20-03/10, TO-206AF

BFY90	1.7	25	9	5	500	21 (13)	200	15	50	200	
LT4772	6	25	19	2.7	1000	7	1000	12	50	750	
MM4049 (5)	5	20	19	3 (13)	500	11.5	500	10	30	200	
MRF501	1	5	8	4.5 (13)	200	15 (13)	200	15	50	200	
MRF502	1.2	5	8	4 (13)	200	17 (13)	200	15	50	200	
MRF524 (5)	4.2	50	—	2.5	500	9	500	10	50	200	
MRF904	4	15	12	1.5 (13)	450	16 (13)	450	15	30	200	
MRF914	4.5	20	13	2 (13)	500	15 (13)	500	12	40	200	

Case 26-03/1

LT3046	3	40	7	2.5	300	15.5	300	20	150	2500	
LT4746	6	25	19	2.7	1000	7	1000	12	50	750	

Case 79-04/1, TO-205AD











2N5109	1.5	50	4	3 (13)	200	11	216	20	400	2500	
2N5583 (5)	1.5	100	5	—	—	—	—	30	500	5000	
2N5943	1.5	50	4	3.4 (13)	200	11.4 (13)	200	30	400	3500	
LT1001A	3	90	7	2.5	300	13.5	300	20	200	3000	
LT4239	5	90	21	2.5	500	14	500	12	400	3000	
LT5239 (5)	4	90	—	4	500	10	50	15	300	3000	
MM8000	0.8	50	1	2.7 (13)	200	11.4 (13)	200	30	400	3500	
MM8001	1	50	4	2.7 (13)	200	11.4 (13)	200	30	400	3500	
MRF517	2.7	60	7	7.5	300	10 (13)	300	20	150	2500	
MRF525 (TO-39CE)	3	50	7	4	400	13	400	20	150	2500	
MRF544	1.4	50	2	—	—	16.5 (13)	250	70	400	3500	
MRF545 (5)	1.2	50	2	—	—	15.5 (13)	250	70	400	3500	
MRF586	4.5	90	17	4	500	9	500	17	200	2500	
PT4579	2.5	90	6	2.3	300	12	300	25	200	3000	
TP3093	3	50	7	3.5	500	8.5	500	20	200	3500	

(5) PNP

(13) Typical

Low-Noise

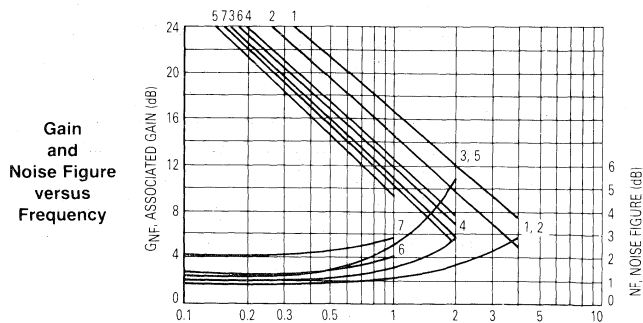
The Small-Signal devices listed are designed for low noise and high gain amplifier mixer, and multiplier applications. Each transistor type is available in various packages. **Polarity is NPN unless otherwise noted.**

Package	Name	Case Number	Curve Number						
			1	2	3 ⁽⁵⁾	4	5	6	7
	MACRO-T	317A-01/2	—	—	—	—	MRF580	—	BFR91
	MACRO-X	317-01/2	—	MRF941 MRF951(27)	MRF521	MRF571 MRF2369(26)	MRF581	MRF901	MRF911
	.1" Ceramic	303-01/1	2N6618 2N6679(27)	MRF942 MRF952(27)	MRF522	MRF572	—	2N6603	—
	.07" Ceramic	303A-01/1	2N6617	—	—	—	—	—	—
	MICRO-X (To Be Introduced)	358-01/1	—	MRF943 MRF953(27)	MRF523	MRF573	—	—	—
	TO-206AF	20-03/10	—	—	MRF524	—	—	MRF904	MRF914
	TO-226AA	29-04/2	—	—	—	MPS571	—	MPS901	MPS911
	SOT-23	318-05/6	—	MMBR941 MMBR951(27)	—	MMBR571	—	MMBR901	MMBR911
	SOT-143	318A-04/1	—	MRF9411 MRF9511(27)	MRF5211	MRF5711 MRF0211(26)	—	MRF9011	—
	SO-8	751-02/1	—	—	—	—	MRF5812	—	—

(5) PNP

(26) Higher Voltage Version

(27) Higher Current Version



CATV, MATV and Class A Linear

For Class A linear CATV/MATV applications. Listed according to increasing gain-bandwidth (f_T).

Device	Nominal Test Conditions V_{CE}/I_C Volts/mA	f_T MHz Typ	Noise Figure	Distortion Specifications				$V_{(BR)CEO}$ V	Package/ Style
			Typ/Freq. dB/MHz	2nd Order IMD	3rd Order IMD	12 Ch. Cross- Mod.	Output Level dBmV		
MRF501	6/5	1000	4.5/200					15	20-03/10
MRF502	6/5	1200	4/200					15	20-03/10
2N5179	6/10	1400	3.2/200					12	20-03/10
MMBR5179	6/5	1500	4/450					12	318-02/6
2N5109	15/50	1500	3/200					20	79-04/1
2N5943	15/50	1500	3.4/200	-50		-4	+50	30	79-04/1
MRF5943	15/50	1500	3.4/200					30	751-02/1
MRF5583 (5)	10/100	1500						30	751-02/1
BFX89	5/25	1600	2.5/500					15	20-03/10
BFY90	5/25	1700	2.5/500					15	20-03/10
2N6304	5/10	1800	3.2/450					15	20-03/10
2N6305	5/10	1800	4/450					15	20-03/10
MMBR4957 (5)	10/2	2000	3/450					30	318-05/6
MMBR5031	6/5	2000	1.9/450					10	318-05/6
MRF511	20/80	2100	7.3/200	-50	-65	-57	+50	25	144D-06/1
MRFQ17	12.5/50	2200						25	751-02/1
PT4572A	14/90	2500	2.3/300					25	244A-01/1
PT4579	14/90	2500	2.3/300					25	79-04/1
TP3098	15/100	2600	6.5/500				1 (28)	20	244A-01/1
MRF517	15/60	2700	6.5/300	-60	-72	-57	+45	20	79-04/1
LT1001A (14)	14/90	3000	2.5/300					20	79-04/1
LT2001	14/90	3000	2.5/300					20	244A-01/1
LT3005	14/90	3000	2.5/300					20	305B-01/1
LT3014 (14)	14/90	3000	3.1/300					20	401-01/1
LT3046	14/90	3000	2.5/300					20	26-03/1
TP3093	15/50	3000	3.5/500				1 (28)	20	79-04/1
TP3400	18/125	3000	7/500				1.2 (28)	20	305B-01/1
LT5217 (5)	14/90	4000	4/500					15	244A-01/1
LT5239 (5)	14/90	4000	4/500					15	79-04/1
MMBR920	10/14	4500	2.4/500					15	318-05/6
BFW92A	10/10	4500	2.7/500					15	317A-01/2
MRF586	15/90	4500	3/500	-50	-72		+50	17	79-04/1
BFR96	10/50	4500	2/500					15	317A-01/2
MRF961	10/50	4500	2/500					15	317-01/2
MRF962	10/50	4500	2/500					15	303-01/1
MRF965	10/50	4500	2/500					15	26-03/1

(5) PNP

(14) Available in JTX equivalent by replacing "LT" with "TX" prefix

(28) Output in volts according to DIN45004B



New introductions

(continued)

Device	Nominal Test Conditions V_{CE}/I_C Volts/mA	f_T MHz Typ	Noise Figure	Distortion Specifications				$V_{(BR)CEO}$ V	Package/ Style
			Typ/Freq. dB/MHz	2nd Order IMD	3rd Order IMD	12 Ch. Cross- Mod.	Output Level dBmV		
BFR90	10/14	5000	2.4/500					15	317A-01/2
BFR91	5/30	5000	1.9/500					12	317A-01/2
LT4217	14/90	5000	4/500					13	244D-01/1
LT4239 (14)	14/90	5000	4/500					13	79-04/1
MRF581	10/75	5000	2/500		-65		+50	18	317-01/2
MRF581A	10/75	5000	1.8/500		-65		+50	15	317-01/2
MRF5812	10/75	5000	1.8/500		-65		+50	15	751-02/1
MRF587	15/90	5500	3/500	-52	-72		+50	17	144D-06/1
LT4700 (14)	8/25	6000	1.6/1000					12	303-01/1
LT4746 (14)	8/25	6000	1.6/500					12	26-03/1
LT4772 (14)	8/25	6000	1.6/500					12	20-03/10
TP3401	12.5/150	5000					1.2 (28)	13	244C-01/1
TP3401S	12.5/150	5000					1.2 (28)	13	249A-01/1
TP3402	12.5/300	5000					1.6 (28)	13	244C-01/1
2N6679	(Has P_1 dB of 18.5 dBm Typ @ 4 GHz)							20	303-01/1

High-Voltage

These discrete devices are specially designed for CRT driver applications requiring high frequency response and high voltage, such as high resolution color graphics video monitors. Gold metallized dice are used to insure high reliability and improved ruggedness.

Device	$V_{(BR)CEO}$ V	$V_{(BR)CBO}$ V	$I_{C(max)}$ mA	h_{FE}	f_T/V_{CE} , I_C (GHz) V, I	C_{CB}/V_{CE} pF/V	Package/ Style
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NPN

LT1739	100 (15)	100	300	15-60	0.9/15, 50	2.5/15	79-04/1
LT1814 (14)	70	120	400	20-60	1/15, 50	3.5/15	401-01/2
LT1817	70	120	400	20-60	1/15, 50	2.5/15	244D-01/2
LT1839 (14)	70	120	300	20-60	1/15, 50	2.5/15	79-04/1
MRF544	70	120	400	15-	1.4/10, 50	1.8/10	79-04/1
MRF542	70	120	400	15-	—	2/10	317D-01/3
MRF546	70	120	600	15-	—	3.6/10	244A-01/3
MRF548	70	120	400	15-	—	2/10	244A-01/3

PNP

LT5817	65	80	400	15-60	1.5/10, 60	1.5/10	244D-01/2
LT5839 (14)	65	80	300	15-60	1.5/10, 60	1.5/10	79-04/1
MRF545	70	100	400	15-	1.2/25, 50	2/10	79-04/1
MRF543	70	100	400	15-	—	2/10	
MRF547	70	100	600	15-	—	3.6/10	244A-01/3
MRF549	70	100	400	15-	—	2/10	244A-01/3

(14) Available in JTX equivalent by replacing "LT" with "TX" prefix

(15) $V_{(BR)CER}$

(28) Output in volts according to DIN45004B



New introductions

High-Speed Switches

The transistors listed below are for use as high-frequency current-mode switches. They are also suitable for RF amplifier and oscillator applications. The devices are listed in ascending order of collector current. These devices are NPN polarity unless otherwise designated.

Device	Test Conditions I _C /V _{CE} mA/Volts	f _T MHz Min	r _b ' C _{cs} ps Max	Package/Style
2N3959	10/10	1300	25	22-03/1
2N3960	10/10	1600	40	22-03/1
2N5835	10/6	2500	5 (13)	20-03/10
MM4049 (5)	20/5	4000	15	20-03/10
MRF914	20/10	4500 (13)	—	20-03/10
2N5583 (5)	50/10	1000	8 (13)	79-04/1
2N5836	50/6	2000	6 (13)	26-03/1
2N5943	50/15	1200	5.5 (13)	79-04/1
2N5837	100/3	1700	6 (13)	26-03/1

UHF and Microwave Oscillators

The transistors listed below are for UHF and microwave oscillator applications as initial signal sources or as output stages of limited range transmitters. Devices are listed in order of increasing output power.

Device	Test Conditions		P _{out} mW Min	f _T MHz Typ	Package/Style
	f MHz	V _{CC} Volts			
2N5179	500	10	20	1400	20-03/10
2N2857	500	10	30	1600	20-03/10
MM8009	1680	20	200	1400	79-04/1
2N5108	1680	20	300	1400	79-04/1
MRF905	1680	20	500 (13)	2200	26-03/1
2N3866	400	15	1000	800	79-04/1
MPS3866	400	15	1000	800	29-04/2
MRF3866	400	15	1000	800	751-02/1

High Reliability (MIL) Transistors

The listed devices are active per QPL-19500 (Qualified Products List). For detailed specification, see indicated page numbers.

Device	Page #	JAN	JTX	JTXV	JANS
2N2857	39	X	X	X	X
2N3553	22	X	X	X	
2N3866	25	X	X	X	
2N3959	43			X	
2N3960	43	X	X	X	
2N4957	39	X	X	X	
2N5109	39	X	X	X	
2N6603	38	X	X	X	
2N6604	38	X	X	X	

(5) PNP (13) Typical

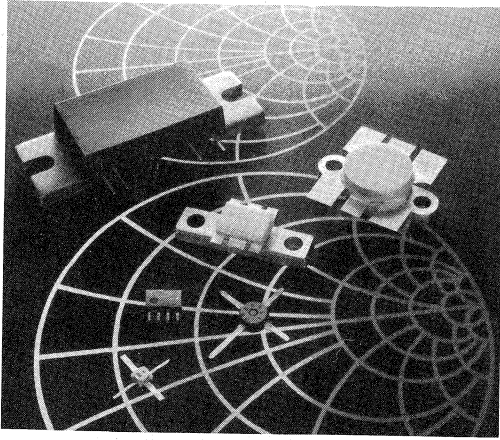


New introductions

Complementary Devices

The transistor complements listed are suitable for most applications requiring NPN and PNP devices of similar RF characteristics. Special matching of complementary transistors is available upon request. See indicated pages for specifications.

NPN	Page #	PNP	Page #
2N2857	39	2N4958	39
2N3866	25	2N5160	25
2N5943	39	2N5583	39
MRF904	39	MM4049	39
MRF571	38	MRF521	36



Volume I

Discrete Transistor Data Sheets

2

2N2857

The RF Line

NPN SILICON RF SMALL-SIGNAL TRANSISTORS

... designed primarily for use in high-gain, low-noise amplifier, oscillator, and mixer applications. Can also be used in UHF converter applications.

- High Current-Gain-Bandwidth Product —
 $f_T = 1.6 \text{ GHz (Typ) @ } I_C = 8.0 \text{ mAdc}$
- Low Collector-Base Time Constant —
 $r_b' C_C = 15 \text{ ps (Max) @ } I_E = 2.0 \text{ mAdc}$
- Characterized with Scattering Parameters
- Ideal for Micro-Power Applications

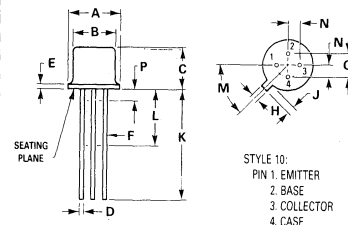
**NPN SILICON
 RF SMALL-SIGNAL
 TRANSISTORS**



***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	2.5	Vdc
Collector Current — Continuous	I_C	40	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	200 1.14	mW mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	300 1.72	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.64	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.52	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.49	0.016	0.019
G	2.54 BSC	—	0.100 BSC	—
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	—	45° BSC	—	45° BSC
N	1.27 BSC	—	0.050 BSC	—
P	—	1.27	—	0.050

**CASE 20-03
 TO-206AF
 (TO-72)**

*ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

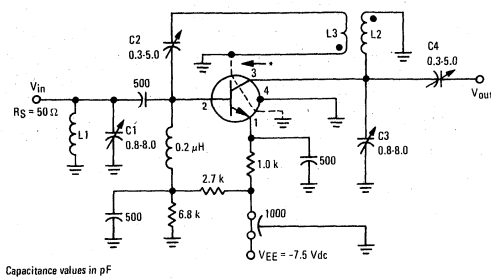
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage** ($I_C = 3.0 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1.0 \text{ } \mu\text{Adc}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.01	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 3.0 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$)	h_{FE}	30	—	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product ① ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 6.0 \text{ Vdc}$, $f = 100 \text{ MHz}$)	f_T	1000	—	1900	MHz
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 0.1 \text{ to } 1.0 \text{ MHz}$)	C_{cb}	—	0.7	1.0	pF
Small-Signal Current Gain ($I_C = 2.0 \text{ mAdc}$, $V_{CE} = 6.0 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	h_{fe}	50	—	220	—
Collector-Base Time Constant ($I_E = 2.0 \text{ mAdc}$, $V_{CB} = 6.0 \text{ Vdc}$, $f = 31.9 \text{ MHz}$)	$r_b' C_c$	4.0	—	15	ps
Noise Figure (Figure 1) ($I_E = 0.1 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$, $R_S = 50 \text{ ohms}$, $f = 450 \text{ MHz}$) ② ($I_C = 1.5 \text{ mAdc}$, $V_{CE} = 6.0 \text{ Vdc}$, $R_S = 50 \text{ ohms}$, $f = 450 \text{ MHz}$)	NF	— —	5.8 4.1	— 4.5	dB
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 1) ($I_E = 0.1 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$, $f = 450 \text{ MHz}$) ② ($I_C = 1.5 \text{ mAdc}$, $V_{CE} = 6.0 \text{ Vdc}$, $f = 450 \text{ MHz}$)	G_{pe}	— 12.5	11 —	— 19	dB
Power Output (Figure 2) ($I_E = 12 \text{ mAdc}$, $V_{CB} = 10 \text{ Vdc}$, $f = 500 \text{ MHz}$)	P_{out}	30	—	—	mW

*Indicates JEDEC Registered Data.

**Motorola guarantees this data in addition to JEDEC Registered Data.

① f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

② Micro-Power Specifications.

FIGURE 1 – TEST CIRCUIT FOR NOISE FIGURE AND POWER GAIN

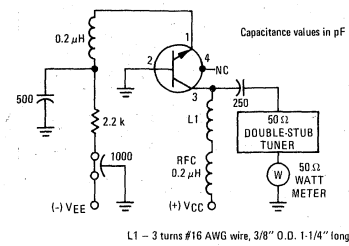
L1, L2 – Silver-plated brass rod, 1-1/2" long and 1/4" dia. Install at least 1/2" from nearest vertical chassis surface.

L3 – 1/2 turn #16 AWG wire, located 1/4" from and parallel to L2.

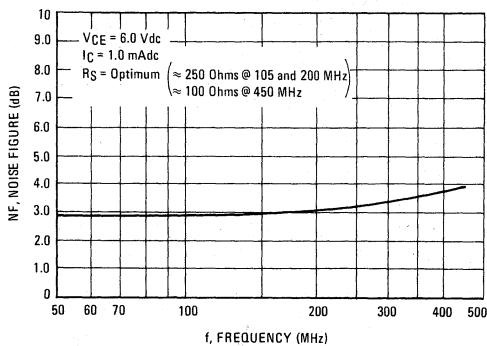
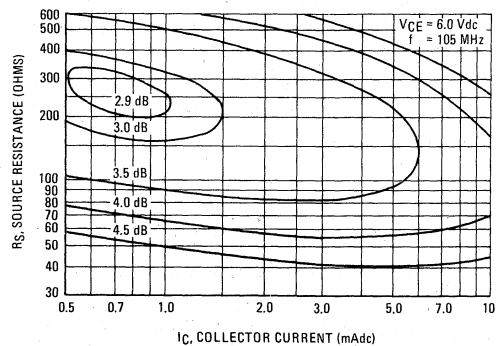
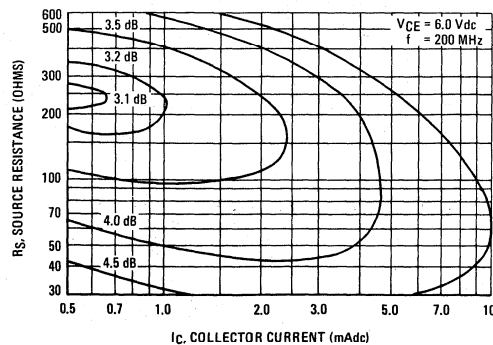
* – External interlead shield to isolate collector lead from emitter and base leads.

Neutralization Procedure:

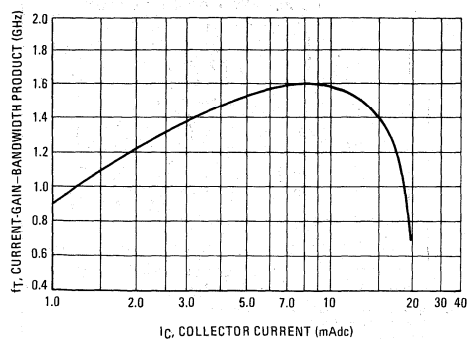
- Connect 450-MHz signal generator (with $R_S = 50$ ohms) to input terminals of amplifier.
- Connect 50-ohm RF voltmeter across output terminals of amplifier.

FIGURE 2 – TEST CIRCUIT FOR OSCILLATOR POWER OUTPUT

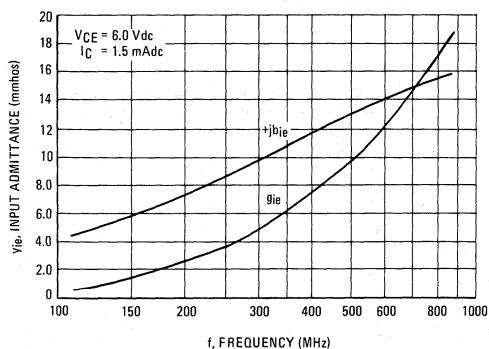
- Apply V_{EE} , and with signal generator adjusted for 5 mV output from amplifier, tune C1, C3, and C4 for maximum output.
- Interchange connections to signal generator and RF voltmeter.
- With sufficient signal applied to output terminals of amplifier, adjust C2 for minimum indication at input.
- Repeat steps (A), (B), and (C) to determine if retuning is necessary.

FIGURE 3 – NOISE FIGURE versus FREQUENCY**FIGURE 4 – NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT****FIGURE 5 – NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT**

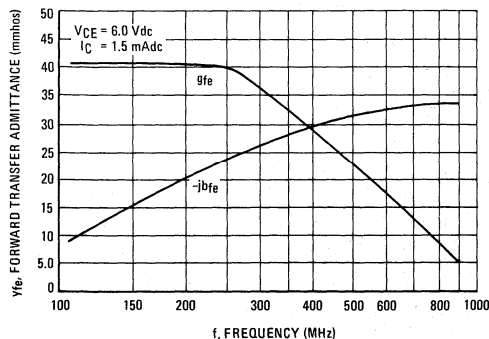
**FIGURE 6 – CURRENT-GAIN–
BANDWIDTH PRODUCT**



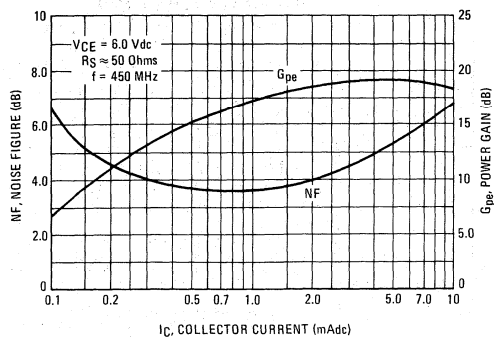
**FIGURE 8 – INPUT ADMITTANCE
versus FREQUENCY**



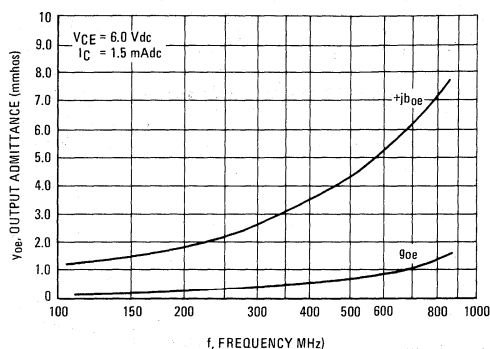
**FIGURE 10 – FORWARD TRANSFER
ADMITTANCE versus FREQUENCY**



**FIGURE 7 – NOISE FIGURE AND POWER GAIN
versus COLLECTOR CURRENT**



**FIGURE 9 – OUTPUT ADMITTANCE
versus FREQUENCY**



**FIGURE 11 – REVERSE TRANSFER
ADMITTANCE versus FREQUENCY**

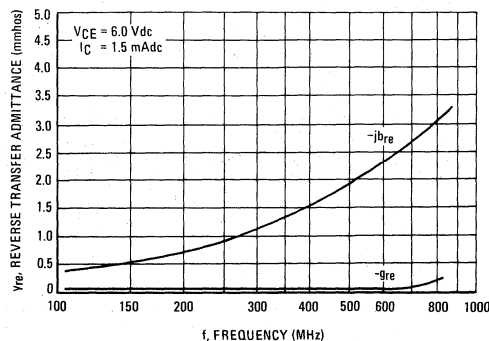


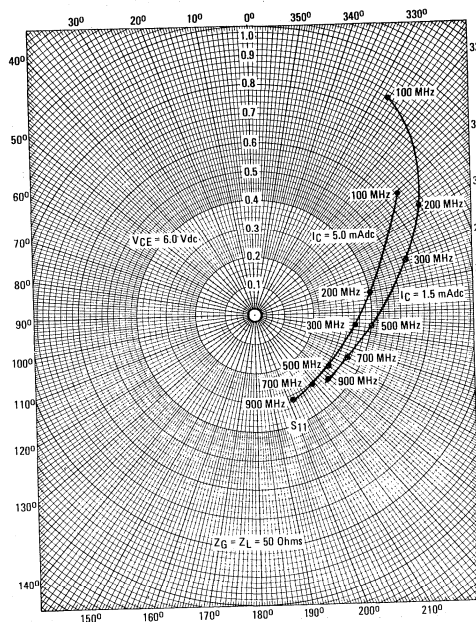
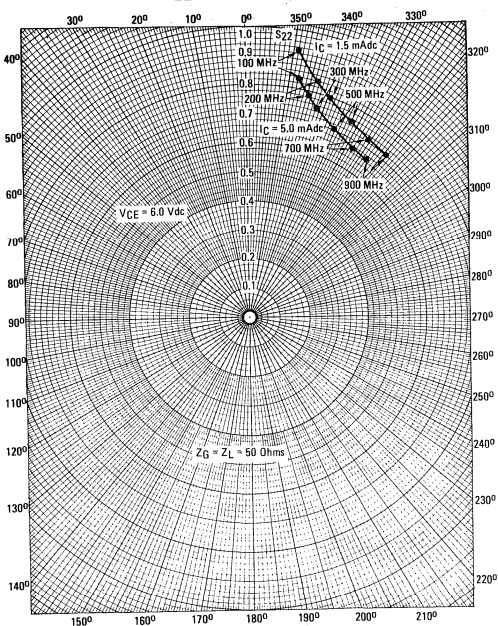
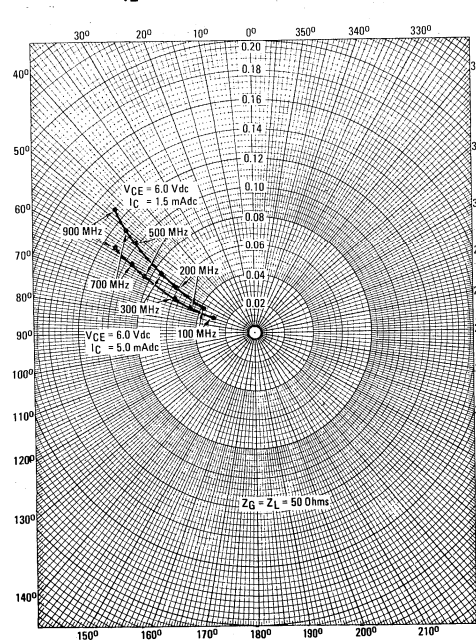
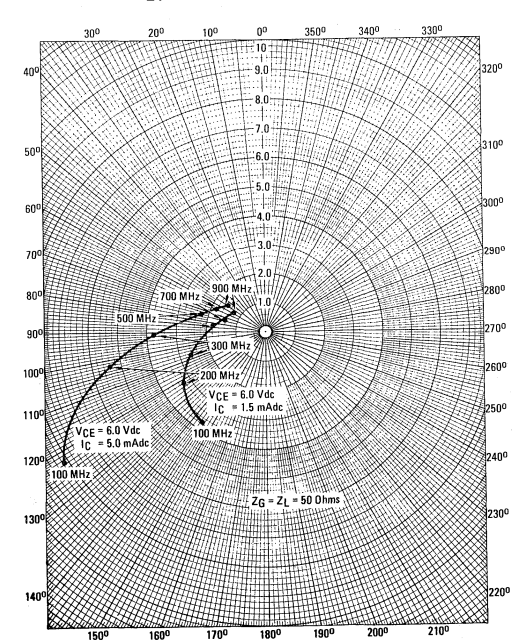
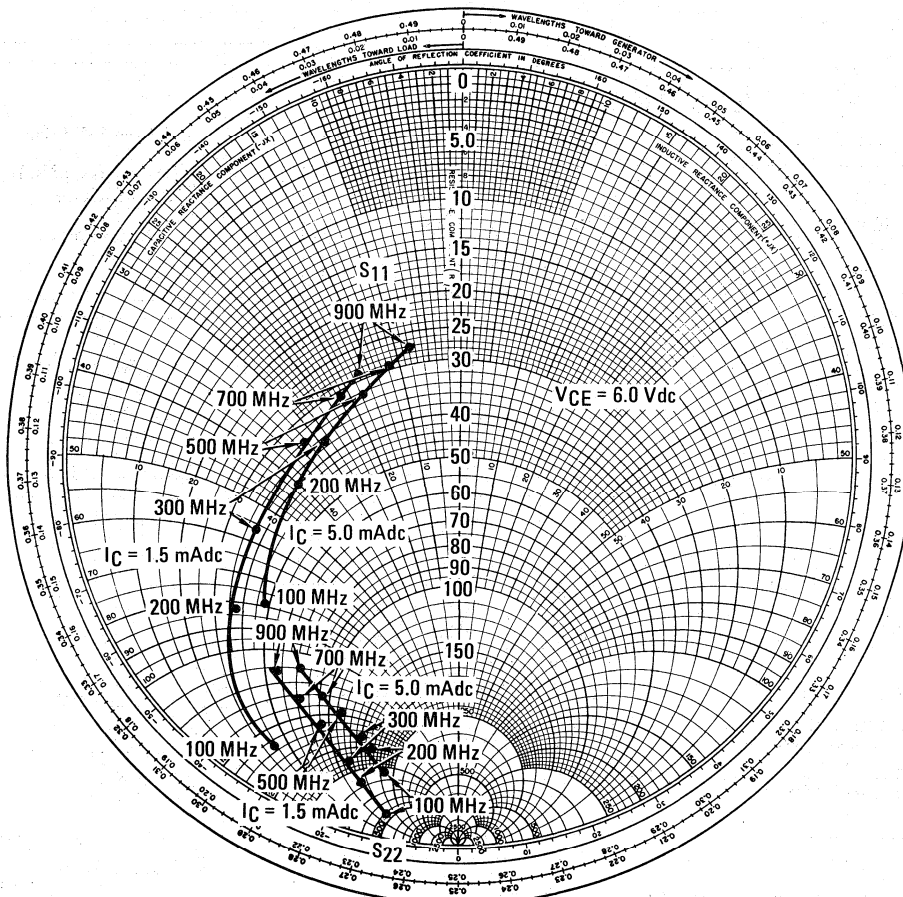
FIGURE 12 — S_{11} , INPUT REFLECTION COEFFICIENTFIGURE 13 — S_{22} , OUTPUT REFLECTION COEFFICIENTFIGURE 14 — S_{12} , REVERSE TRANSMISSION COEFFICIENTFIGURE 15 — S_{21} , FORWARD TRANSMISSION COEFFICIENT

FIGURE 16 — S_{11} , INPUT REFLECTION COEFFICIENT AND S_{22} , OUTPUT REFLECTION COEFFICIENT

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

... designed for amplifier and oscillator applications in military and industrial equipment. Suitable for use as output, driver or pre-driver stages in VHF equipment.

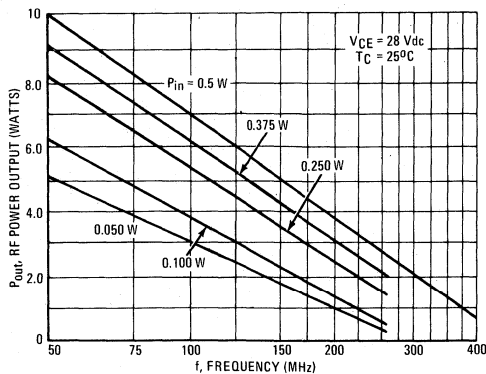
- Specified 175 MHz, 28 Vdc Characteristics —
Output Power = 2.5 Watts
Minimum Gain = 10 dB
Efficiency = 50%

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE}	40	Vdc
Collector-Base Voltage	V_{CB}	65	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current	I_C	1.0	A dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	7.0 40	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

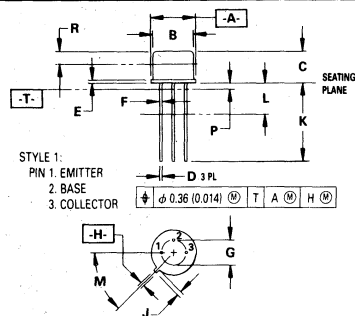
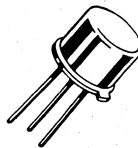
FIGURE 1 — OUTPUT POWER versus FREQUENCY



2N3553

2.5 W — 175 MHz
HIGH FREQUENCY
TRANSISTOR

NPN SILICON



NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.
- DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
- DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
- DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

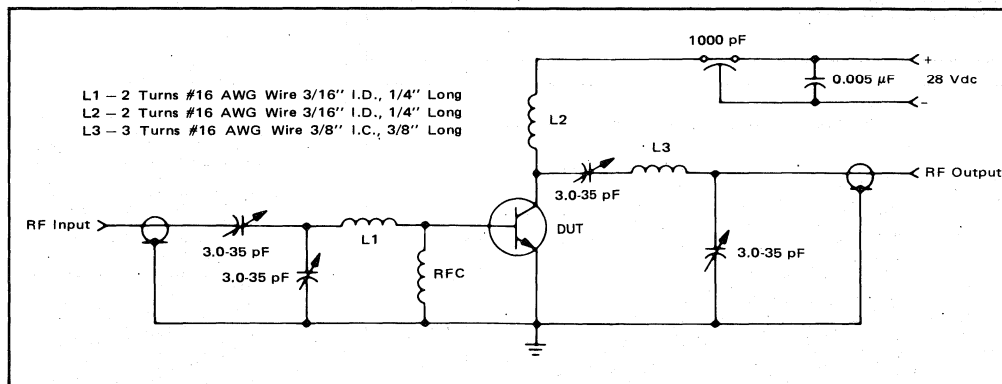
***ELECTRICAL CHARACTERISTICS** ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (1) ($I_C = 200\text{ mA}$, $I_B = 0$)	$V_{CE(sus)}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	0.1	mA
Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{BE(off)} = 1.5\text{ Vdc}$, $T_C = 200^\circ\text{C}$) ($V_{CE} = 65\text{ Vdc}$, $V_{BE(off)} = 1.5\text{ Vdc}$)	I_{CEX}	— —	— —	5.0 1.0	mA
Emitter Cutoff Current ($V_{BE} = 4.0\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	0.1	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 250\text{ mA}$, $I_B = 50\text{ mA}$)	$V_{CE(sat)}$	—	—	1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product ($I_C = 100\text{ mA}$, $V_{CE} = 28\text{ Vdc}$, $f = 100\text{ MHz}$)	f_T	—	500	—	MHz
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 100\text{ kHz}$)	C_{ob}	—	8.0	10	pF
FUNCTIONAL TESTS					
Power Input ($V_{CE} = 28\text{ Vdc}$, $P_{out} = 2.5\text{ Watts}$, $f = 175\text{ MHz}$)	P_{in}	—	—	0.25	Watt
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ Vdc}$, $P_{out} = 2.5\text{ Watts}$, $f = 175\text{ MHz}$)	G_{pe}	10	—	—	dB
Collector Efficiency ($V_{CE} = 28\text{ Vdc}$, $P_{out} = 2.5\text{ Watts}$, $f = 175\text{ MHz}$)	η	50	—	—	%

*Indicates JEDEC Registered Data

(1) Pulsed thru a 25 mH inductor.

FIGURE 2 – 175 MHz TEST CIRCUIT SCHEMATIC



The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed for amplifier and oscillator applications in military and industrial equipment. Suitable for use as output, driver or pre-driver stages in VHF and UHF equipment.

- Specified 400 MHz, 28 Vdc Characteristics —
 Output Power = 1.0 Watt
 Minimum Gain = 10 dB
 Efficiency = 45%
- Large Signal Series Equivalent Impedances
- S-Parameter Characterization

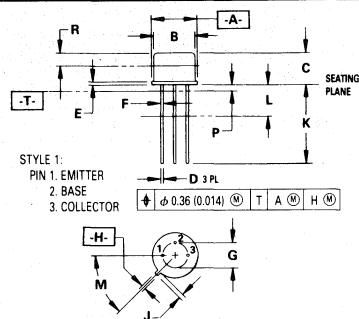
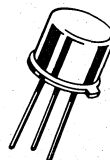
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate Above 25°C	P_D	5.0 28.6	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data

2N3866
2N3866A

1.0 W — 400 MHz
HIGH FREQUENCY
TRANSISTOR
 NPN SILICON



NOTES:

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DIM	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted).

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage ($I_C = 5.0\text{ mAdc}$, $I_B = 0$)	$V_{CE(sus)}$	30	—	Vdc
Collector-Base Sustaining Voltage ($I_C = 5.0\text{ mAdc}$, $R_{BE} = 10\ \Omega$)	$V_{CER(sus)}$	55	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	Vdc
Collector Cutoff Current ($V_{CE} = 28\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	0.02	mAdc
Emitter Cutoff Current ($V_{BE} = 3.5\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	0.1	mAdc
Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{BE} = -1.5\text{ Vdc (Rev.)}$, $T_C = 200^\circ\text{C}$) ($V_{CE} = 55\text{ Vdc}$, $V_{BE} = -1.5\text{ Vdc (Rev.)}$)	I_{CEX}	— —	5.0 0.1	mAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 360\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$) ($I_C = 50\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0 10 25	— 200 200	—
Collector-Emitter Saturation Voltage ($I_C = 100\text{ mAdc}$, $I_B = 20\text{ mAdc}$)	$V_{CE(sat)}$	—	1.0	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50\text{ mAdc}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	500 800	— —	MHz
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	3.0	pF
FUNCTIONAL TESTS				
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	10	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 400\text{ MHz}$)	η	45	—	%

*Indicates JEDEC Registered Data.

FIGURE 1 — 400 MHz TEST CIRCUIT SCHEMATIC

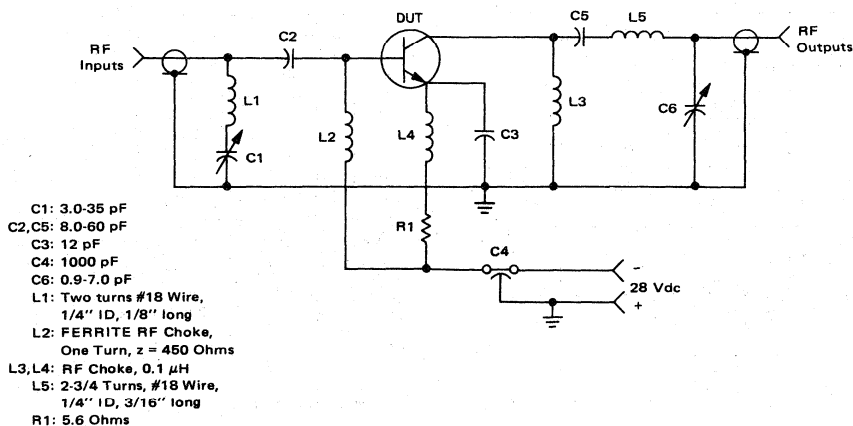


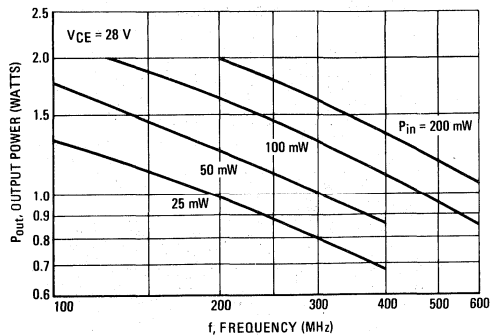
FIGURE 2 – POWER OUTPUT versus
FREQUENCY (Class C)

FIGURE 3 – CURRENT-GAIN – BANDWIDTH PRODUCT

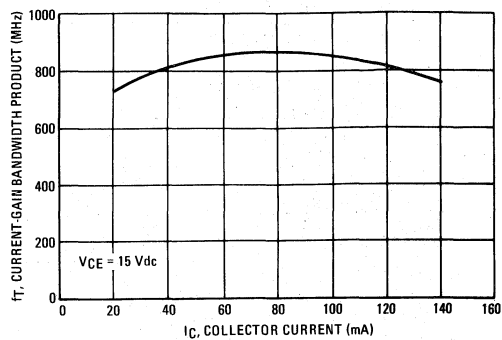


FIGURE 4 – COLLECTOR-BASE TIME CONSTANT

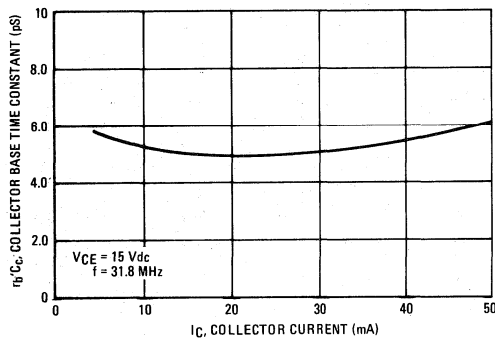


FIGURE 5 – OUTPUT CAPACITANCE

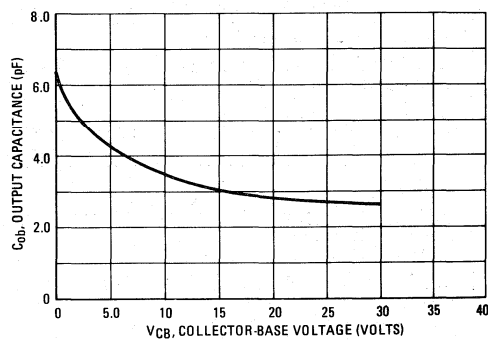
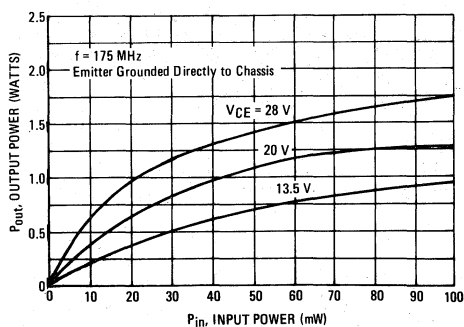
FIGURE 6 – OUTPUT POWER versus INPUT POWER
(CLASS C)

FIGURE 7 – SMALL-SIGNAL CURRENT GAIN

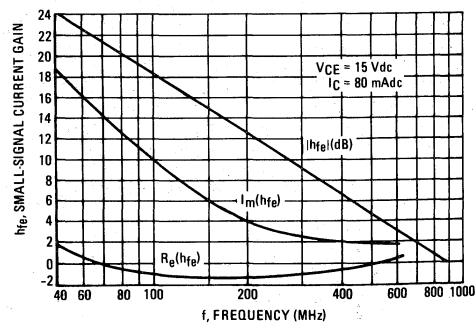


FIGURE 8 — LARGE-SIGNAL SERIES EQUIVALENT IMPEDANCES

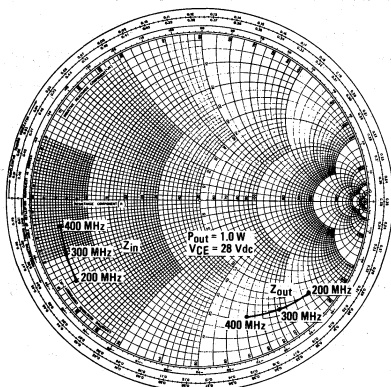


FIGURE 10 — S_{21} versus FREQUENCY

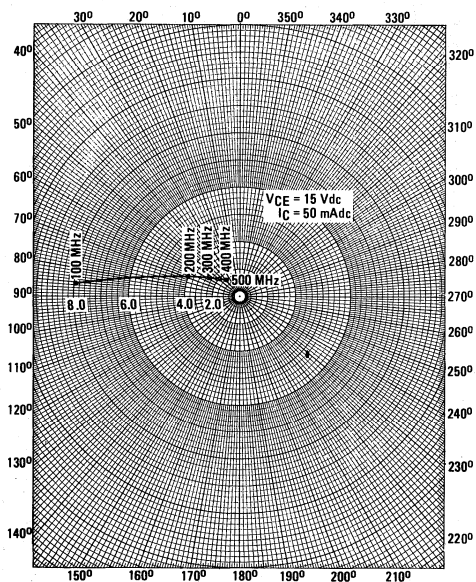


FIGURE 9 — S_{11} AND S_{22} versus FREQUENCY

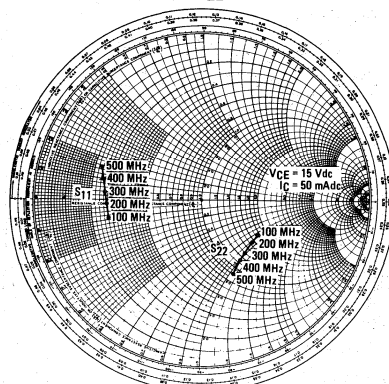
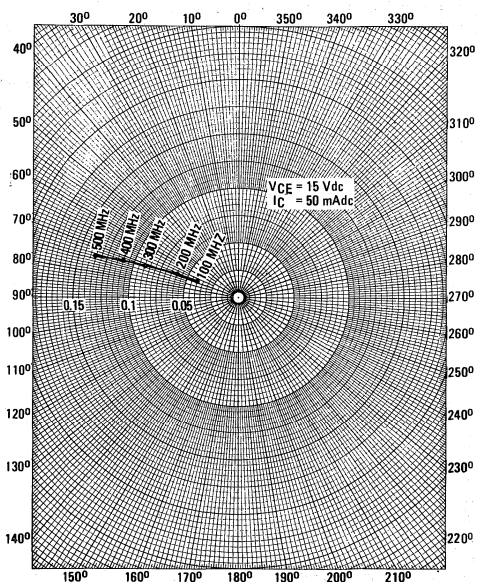


FIGURE 11 — S_{12} versus FREQUENCY



2N3924

The RF Line

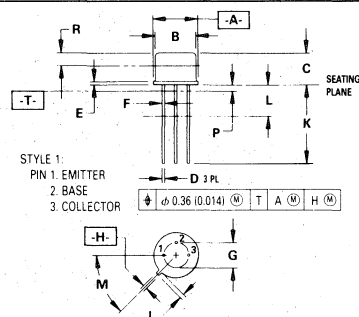
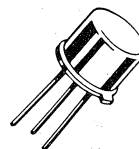
2

NPN SILICON RF POWER TRANSISTOR

... optimized Annular transistor for large-signal power-amplifier and driver applications to 300 MHz.

- Designed for 13.6 Volt Operation
- High Output Power — 4.0 W Min @ $f = 175$ MHz
- Multiple-Emitter Construction for Excellent High-Frequency Performance
- Guaranteed Safe Operating Area
 $V_{CE(sus)}$ Measured at $I_C = 200$ mA dc

**NPN SILICON
RF POWER TRANSISTOR**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
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DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-04
TO-205AD
(TO-39)**

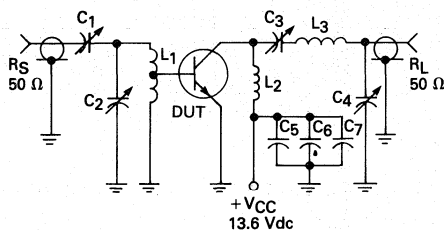
***MAXIMUM RATINGS** ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE}	18	Vdc
Collector-Base Voltage	V_{CB}	36	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current	I_C	0.5	Adc
Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	7.0 40	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.

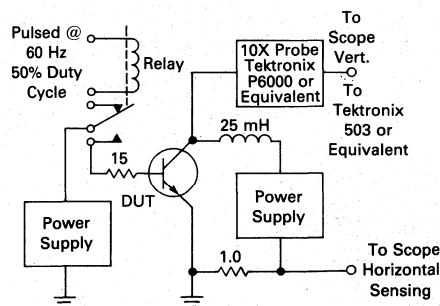
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (Figure 2) ($I_C = 200\text{ mA}$)	$V_{CEO(sus)}$	18	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.25\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $T_A = 150^\circ\text{C}$)	I_{CBO}	—	—	0.1 5.0	mA
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 100\text{ mA}$, $V_{CE} = 13.6\text{ Vdc}$, $f = 100\text{ MHz}$)	f_T	—	350	—	MHz
Output Capacitance ($V_{CB} = 13.6\text{ Vdc}$, $I_E = 0$, $f = 100\text{ kHz}$)	C_{ob}	—	12.5	20	pF
FUNCTIONAL TESTS					
Power Input	Test Circuit Figure 1	P_{in}	—	—	1.0 Watt
Common-Emitter Amplifier Power Gain	$V_{CE} = 13.6\text{ Vdc}$, $R_S = 50\text{ ohms}$, $R_L = 50\text{ ohms}$, $f = 175\text{ MHz}$	G_{pe}	6.0	7.3	— dB
Collector Efficiency	$P_{out} = 4.0\text{ Watts}$	η	70	—	— %

FIGURE 1 — 175 MHz TEST CIRCUIT

C_1, C_2, C_4 5–50 pF (Air variable)
 C_3 7–100 pF (Air variable)
 C_5 470 pF (Disc ceramic)
 C_6 0.01 μF (Disc ceramic)
 C_7 0.001 μF (Disc ceramic)

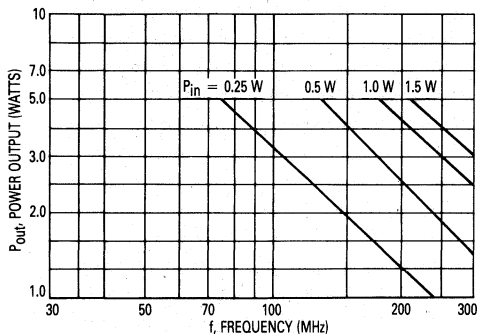
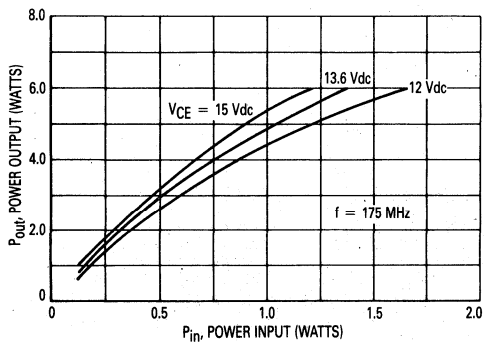
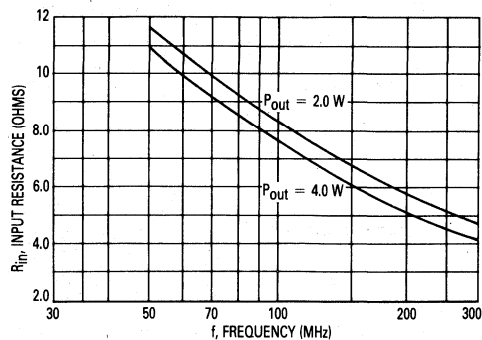
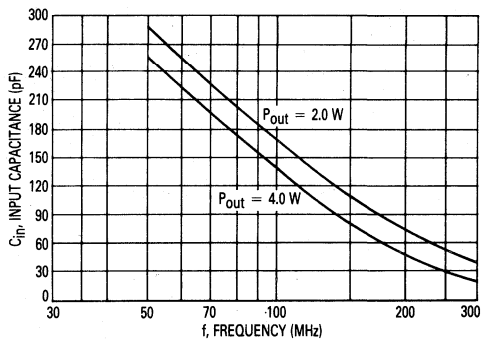
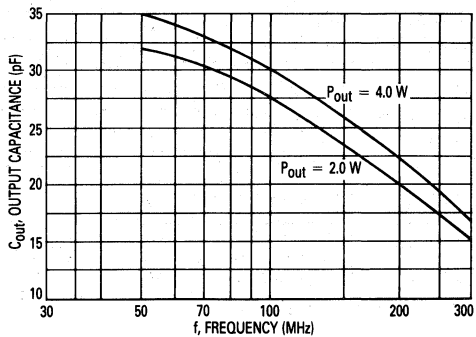
L_1 — 1½ turns #14 AWG tinned wire; ¾" ID Air wound; winding length ¾"; base tapped 1 turn from ground
 L_2 — RFC
 L_3 — 2 turns #14 AWG tinned wire; ¼" ID Air wound; winding length ¾"

FIGURE 2 — PULSE TEST CIRCUIT

CLASS C DESIGN DATA FOR $V_{CE} = 13.6 \text{ Vdc}$, $T_C = 25^\circ\text{C}$

(Emitter Grounded Directly to the Chassis — No Tuned-Emitter Techniques Used)

2

FIGURE 3 — POWER OUTPUT versus FREQUENCY**FIGURE 4 — POWER OUTPUT versus POWER INPUT****FIGURE 5 — PARALLEL EQUIVALENT INPUT RESISTANCE****FIGURE 6 — PARALLEL EQUIVALENT INPUT CAPACITANCE****FIGURE 7 — PARALLEL EQUIVALENT OUTPUT CAPACITANCE**

2N3948

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

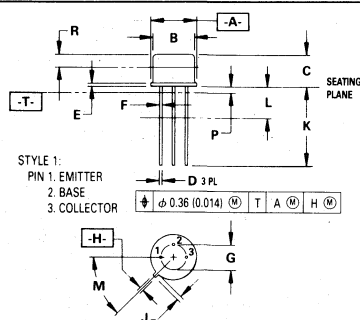
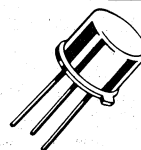
... designed for amplifier applications in industrial and commercial equipment. Suitable for use as output, driver or pre-driver stages in UHF equipment.

- Specified 400 MHz, 13.6 Vdc Characteristics —
 Output Power = 1.0 Watt
 Minimum Gain = 6.0 dB
 Efficiency = 45%

1.0 W — 400 MHz

**HIGH FREQUENCY
 TRANSISTOR**

NPN SILICON



STYLE 1:
 PIN 1. EMITTER
 2. BASE
 3. COLLECTOR

- NOTES:
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DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-04
 TO-205AD
 (TO-39)**

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CB}	36	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current — Continuous	I_C	400	mA dc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1.0 5.71	Watt mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

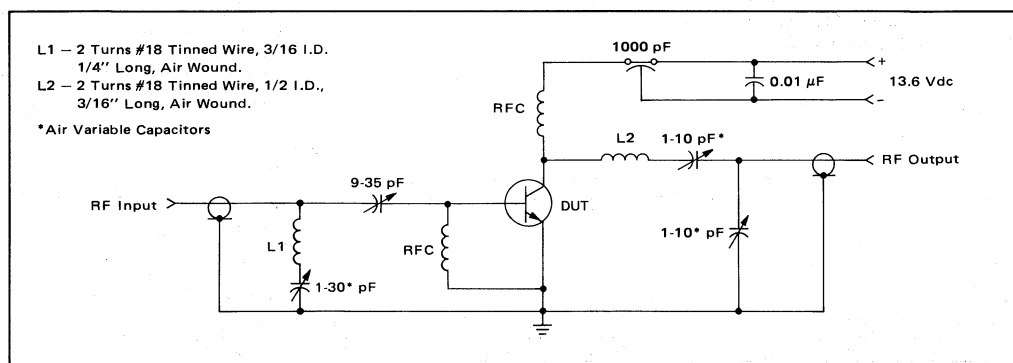
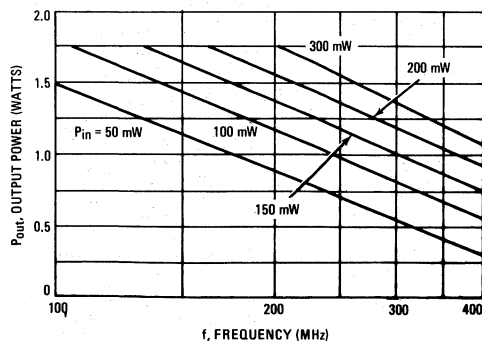
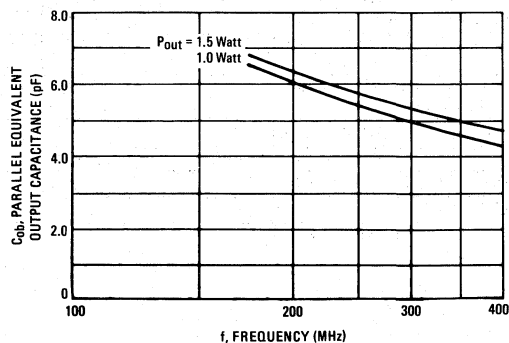
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	$^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	$^\circ\text{C/W}$

*Indicates JEDEC Registered Data

***ELECTRICAL CHARACTERISTICS** ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit	
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage ($I_C = 5.0\text{ mA}$, $I_E = 0$)	$V_{CE(sus)}$	20	—	Vdc	
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	Vdc	
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	Vdc	
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $T_A = 150^{\circ}\text{C}$)	I_{CBO}	— —	0.1 100	μAdc	
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	15	—	—	
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_E = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	700	—	MHz	
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	4.5	pF	
FUNCTIONAL TEST					
Power Gain	($V_{CC} = 13.6\text{ Vdc}$, $f = 400\text{ MHz}$, $P_{in} = 0.25\text{ W}$)	G_{pe}	6.0	—	dB
Output Power		P_{out}	1.0	—	Watt
Collector Efficiency		η	45	—	%

*Indicates JEDEC Registered Data

FIGURE 1 — 400 MHz RF AMPLIFIER TEST CIRCUIT**FIGURE 2 — OUTPUT POWER versus FREQUENCY****FIGURE 3 — PARALLEL EQUIVALENT OUTPUT CAPACITANCE**

2N3959
2N3960

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

... designed for high-speed current-mode logic switching applications.

- High Current-Gain-Bandwidth Product —
 $f_T = 1800 \text{ MHz (Typ) @ } I_C = 10 \text{ mA dc}$
- Low Input and Output Capacitance —
 C_{ib} and $C_{ob} = 2.5 \text{ pF (Max)}$
- Excellent Current-Mode Performance —
 $t_r = 1.7 \text{ ns (Typ) @ } I_C = 30 \text{ mA dc}$
- Low Collector-Base Time Constant —
 $r_b' C_c = 25 \text{ ps (Max) @ } I_C = 10 \text{ mA dc} - 2N3959$

Current-Mode logic operation, because of the absence of storage time, offers improved high-speed performance for digital applications. In addition, the low impedance drive circuit offers improved delay, rise, and fall times. The basic characteristics of importance in current-mode logic applications are Current-Gain-Bandwidth Product (f_T), Input and Output Capacitance (C_{ib} and C_{ob}), and Base Spreading Resistance (r_b').

The 2N3959 and 2N3960 offer a combination of extremely high f_T values, low capacitances, and low base spreading resistance which results in exceptionally high speed in current-mode logic circuits.

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CB}	20	Vdc
Emitter-Base Voltage	V_{EB}	4.5	Vdc
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	400 2.3	mW mW/ $^\circ\text{C}$
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	750 4.3	mW mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

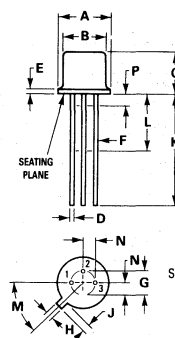
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.436	$^\circ\text{C/mW}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.233	$^\circ\text{C/mW}$

*Indicates JEDEC Registered Data.

1.8 GHz — 10 mA dc

HIGH FREQUENCY TRANSISTORS

NPN SILICON



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.406	0.533	0.016	0.021
E	—	0.762	—	0.030
F	0.406	0.483	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 22-03
TO-206AA
(TO-18)

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Fig. No.	Symbol	Min	Typ	Max	Unit
*OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	—	$V_{(BR)CEO}$	12	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	—	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	—	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Reverse Current ($V_{CE} = 10\text{ Vdc}$, $V_{EB} = 2.0\text{ Vdc}$) ($V_{CE} = 10\text{ Vdc}$, $V_{EB} = 2.0\text{ Vdc}$, $T_A = 150^\circ\text{C}$)	—	I_{CEX}	—	—	0.005 5.0	μAdc
Base Cutoff Current ($V_{CE} = 10\text{ Vdc}$, $V_{EB} = 2.0\text{ Vdc}$)	—	I_{BL}	—	—	0.005	μAdc
Collector Forward Current ($V_{CE} = 5.0\text{ Vdc}$, $V_{BE} = 0.4\text{ Vdc}$)	—	I_{CEX}	—	—	1.0	μAdc
*ON CHARACTERISTICS						
DC Current Gain ($I_C = 1.0\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 10\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 30\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$)	1	h_{FE}	25 40 25	— — —	— 400 —	—
Collector-Emitter Saturation Voltage ($I_C = 1.0\text{ mA}$, $I_B = 0.1\text{ mA}$) ($I_C = 30\text{ mA}$, $I_B = 3.0\text{ mA}$)	—	$V_{CE(sat)}$	— —	— —	0.2 0.3	Vdc
Base-Emitter "on" Voltage ($I_C = 1.0\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$) ($I_C = 30\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$)	—	$V_{BE(on)}$	— —	— —	0.8 1.0	Vdc
*DYNAMIC CHARACTERISTICS						
Current-Gain-Bandwidth Product ($I_C = 5.0\text{ mA}$, $V_{CE} = 4.0\text{ Vdc}$, $f = 100\text{ MHz}$) ($I_C = 10\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 100\text{ MHz}$) ($I_C = 30\text{ mA}$, $V_{CE} = 4.0\text{ Vdc}$, $f = 100\text{ MHz}$)	2	f_T	1000 1300 1300 1600 1000 1200	— — — — — —	— — — — — —	MHz
Output Capacitance ($V_{CB} = 4.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	4	C_{ob}	—	2.0	2.5	pF
Input Capacitance ($V_{EB} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 100\text{ MHz}$)	4	C_{ib}	—	1.5	2.5	pF
Collector-Base Time Constant ($I_C = 5.0\text{ mA}$, $V_{CE} = 4.0\text{ Vdc}$) ($I_C = 10\text{ mA}$, $V_{CE} = 10\text{ Vdc}$) ($I_C = 30\text{ mA}$, $V_{CE} = 4.0\text{ Vdc}$)	3	$r_b'C_c$	— — — — — —	— — — — — —	30 50 25 40 30 50	ps
SWITCHING CHARACTERISTICS (Figure 7)						
Turn-On Delay Time ($I_C = 10\text{ mA}$, $V_{out} = 1.0\text{ Vdc}$) ($I_C = 30\text{ mA}$, $V_{out} = 1.0\text{ Vdc}$)	—	$t_{d(on)}$	— —	2.4 2.0	— —	ns
Rise Time ($I_C = 10\text{ mA}$, $V_{out} = 1.0\text{ Vdc}$) ($I_C = 30\text{ mA}$, $V_{out} = 1.0\text{ Vdc}$)	Both Devices 2N3959 2N3960	t_r	— — —	3.0 2.2 1.7	— — —	ns
Turn-Off Delay Time ($I_C = 10\text{ mA}$, $V_{out} = 1.0\text{ Vdc}$) ($I_C = 30\text{ mA}$, $V_{out} = 1.0\text{ Vdc}$)	—	$t_{d(off)}$	— —	1.6 1.6	— —	ns
Fall Time ($I_C = 10\text{ mA}$, $V_{out} = 1.0\text{ Vdc}$) ($I_C = 30\text{ mA}$, $V_{out} = 1.0\text{ Vdc}$)	Both Devices 2N3959 2N3960	t_f	— — —	3.3 2.3 1.9	— — —	ns

*Indicates JEDEC Registered Data.

FIGURE 1 – TYPICAL DC CURRENT GAIN

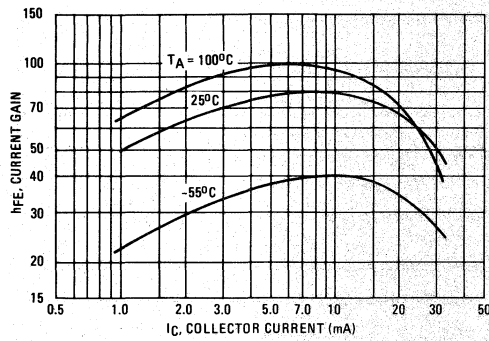


FIGURE 2 – TYPICAL CURRENT-GAIN – BANDWIDTH PRODUCT

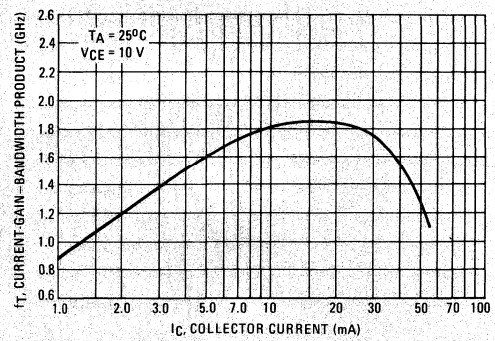


FIGURE 3 – TYPICAL COLLECTOR-BASE TIME CONSTANT

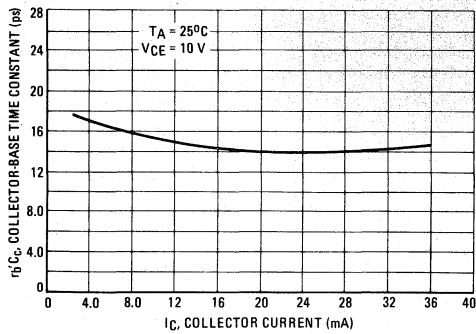
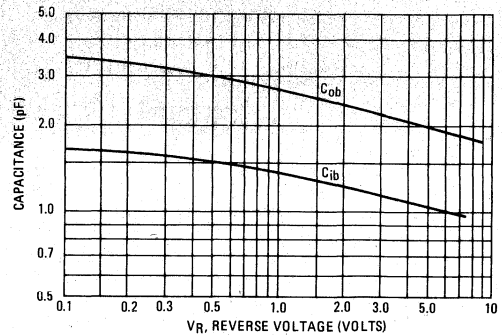


FIGURE 4 – TYPICAL JUNCTION CAPACITANCE



TURN-ON AND TURN-OFF TIMES

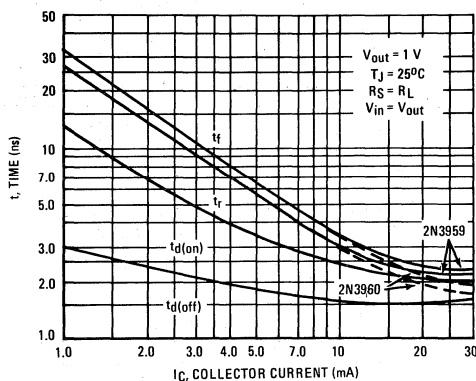
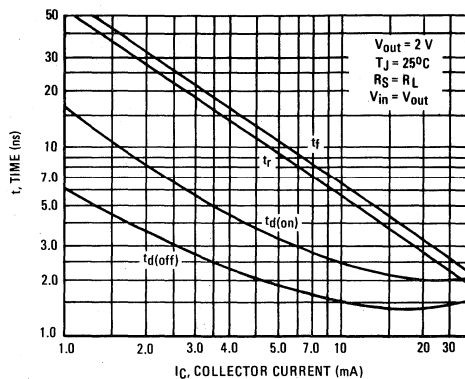
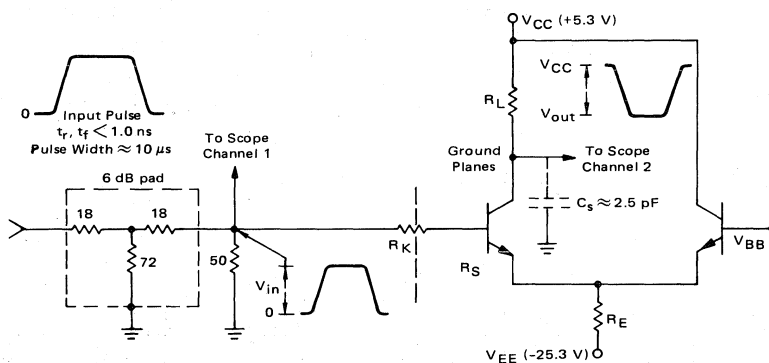
FIGURE 5 — $V_{out} = 1.0 \text{ Vdc}$ FIGURE 6 — $V_{out} = 2.0 \text{ Vdc}$ 

FIGURE 7 — SWITCHING TIMES TEST CIRCUIT



This test set up is designed to simulate a cascade of identical stages. The source resistance (R_S) equals the load resistance (R_L). Values used in the test are shown in the table.

For $V_{in} = V_{out} = 1 \text{ V}$, $V_{BB} = +0.5 \text{ V}$, R_L & R_K values appropriately reduced.

$V_{in} = V_{out} = 2 \text{ volts}$, $V_{BB} = +1.0 \text{ V}$			
I_C (mA)	R_E (k Ω)	R_L (Ω)	R_K (Ω)
1.0	24.0	2.0 k	2.0 k
3.0	8.2	680	680
10	2.4	200	180
30	0.8	68	36

2N4427

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

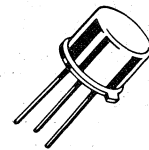
... designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- Specified 175 MHz, 12 Vdc Characteristics —
 Output Power = 1.0 Watt
 Minimum Gain = 10 dB
 Efficiency = 50%

1 W — 175 MHz

**HIGH FREQUENCY
 TRANSISTOR**

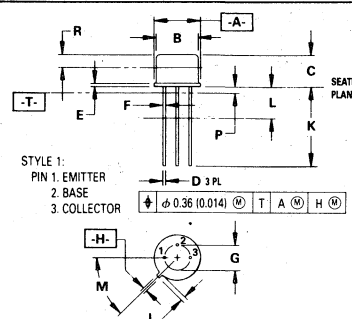
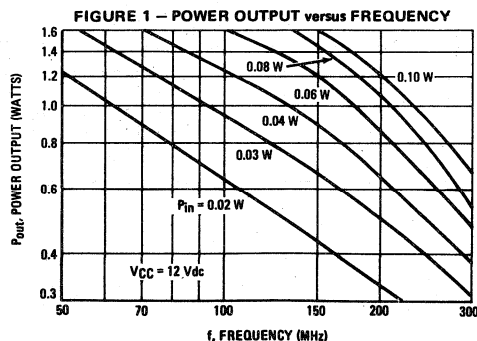
NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
*Collector-Emitter Voltage	V_{CEO}	20	Vdc
*Collector-Base Voltage	V_{CB}	40	Vdc
*Emitter-Base Voltage	V_{EB}	2.0	Vdc
*Collector Current — Continuous	I_C	400	mA dc
*Base Current — Continuous	I_B	400	mA dc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1.0 6.71	Watt mW/ $^\circ\text{C}$
*Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	3.5 20	Watts mW/ $^\circ\text{C}$
*Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data



- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 - CONTROLLING DIMENSION: INCH.
 - DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
 - DIMENSION B SHALL NOT VARY MORE THAN 0.025 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
 - DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

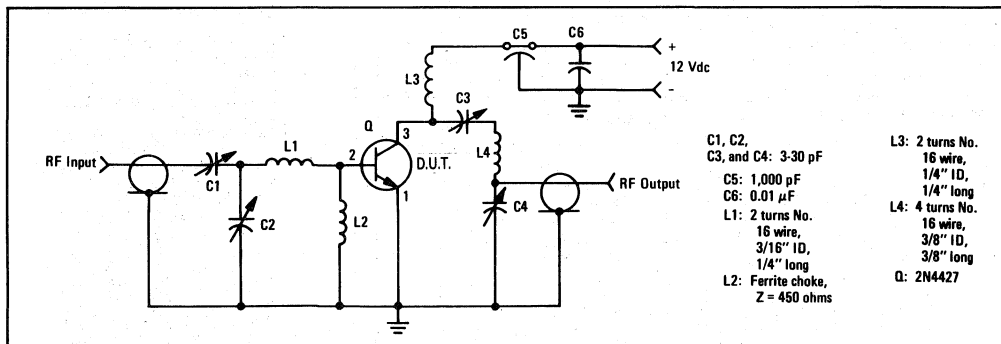
**CASE 79-04
 TO-205AD
 (TO-39)**

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
*Collector-Emitter Sustaining Voltage ($I_C = 5.0\text{ mAdc}$, $I_B = 0$)	$V_{CEO(sus)}$	20	—	Vdc
*Collector-Emitter Sustaining Voltage ($I_C = 5.0\text{ mAdc}$, $R_{BE} = 10\text{ ohms}$)	$V_{CER(sus)}$	40	—	Vdc
*Collector Cutoff Current ($V_{CE} = 12\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	0.02	mAac
*Collector Cutoff Current ($V_{CE} = 40\text{ Vdc}$, $V_{BE} = -1.5\text{ Vdc}$) ($V_{CE} = 12\text{ Vdc}$, $V_{BE} = -1.5\text{ Vdc}$, $T_C = +150^\circ\text{C}$)	I_{CEV}	—	0.1 5.0	mAac
*Emitter Cutoff Current ($V_{EB} = 2.0\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	0.1	mAac
ON CHARACTERISTICS				
*DC Current Gain ($I_C = 100\text{ mAac}$, $V_{CE} = 5.0\text{ Vdc}$) ($I_C = 360\text{ mAac}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10 5.0	200 —	—
*Collector-Emitter Saturation Voltage ($I_C = 100\text{ mAac}$, $I_B = 20\text{ mAac}$)	$V_{CE(sat)}$	—	0.5	Vdc
DYNAMIC CHARACTERISTICS				
*Current-Gain — Bandwidth Product ($I_C = 50\text{ mAac}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	500	—	MHz
*Output Capacitance ($V_{CB} = 12\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	4.0	pF
FUNCTIONAL TEST				
*Power Input (Figure 2) ($P_{out} = 1.0\text{ W}$, $V_{CC} = 12\text{ Vdc}$, $f = 175\text{ MHz}$)	P_{in}	—	100	mW
Common-Emitter Amplifier Power Gain ($P_{in} = 100\text{ mW}$, $V_{CC} = 12\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{pe}	10	—	dB
*Collector Efficiency (Figure 2) ($P_{out} = 1.0\text{ W}$, $V_{CC} = 12\text{ Vdc}$, $f = 175\text{ MHz}$)	η	50	—	%

*Indicates JEDEC Registered Data

FIGURE 2 — 175 MHz RF AMPLIFIER CIRCUIT FOR POWER-OUTPUT TEST



2N4428

The RF Line

NPN SILICON RF POWER TRANSISTOR

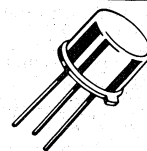
... designed primarily for use in large signal VHF and UHF amplifier output stages in military and industrial communications applications.

- Specified 28 Volt, 500 MHz Characteristics —
Output Power = 750 mW
Typical Gain = 10 dB
Efficiency = 35%

0.75 W — 500 MHz

**RF POWER
TRANSISTOR**

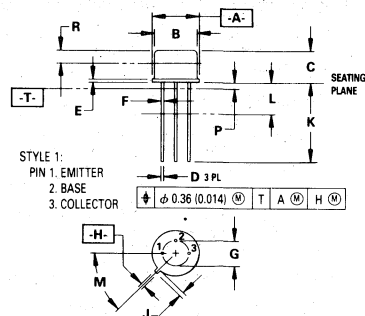
NPN SILICON



***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	55	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current — Continuous	I_C	425	mA dc
Base Current — Continuous	I_B	150	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	3.5 20	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

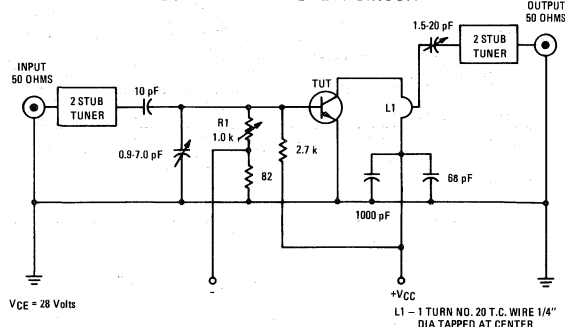


- STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08	BSC	0.200	BSC
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	—	45° BSC	—	45° BSC
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-04
TO-205AD
(TO-39)**

FIGURE 1 — 500 MHz TEST CIRCUIT



Adjust R1 for $I_C = 70$ mA with
no RF Signal Applied

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{CE(sus)}$	35	—	—	Vdc
Collector-Emitter Sustaining Voltage ($I_C = 20\text{ mA}$, $R_{BE} = 10\text{ ohms}$)	$V_{CER(sus)}$	55	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 55\text{ Vdc}$, $V_{BE(on)} = -1.5\text{ Vdc}$)	I_{CEX}	—	—	1.0	mA
Emitter Cutoff Current ($V_{EB} = 3.5\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	0.1	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$) ($I_C = 400\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20 5.0	— —	200 —	—
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product ($I_C = 50\text{ mA}$, $V_{CE} = 20\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	700	1000	—	MHz
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	1.2	3.5	pF
FUNCTIONAL TEST					
Power Input (Figure 1) ($P_{out} = 750\text{ mW}$, $V_{CE} = 28\text{ Vdc}$, $R_S = 50\text{ Ohms}$, $f = 500\text{ MHz}$)	P_{in}	—	—	75	mW
Collector Efficiency (Figure 1) ($P_{out} = 750\text{ mW}$, $V_{CE} = 28\text{ Vdc}$, $R_S = 50\text{ Ohms}$, $f = 500\text{ MHz}$)	η	35	—	—	%

*Indicates JEDEC Registered Data.

FIGURE 2 — CURRENT-GAIN-BANDWIDTH PRODUCT

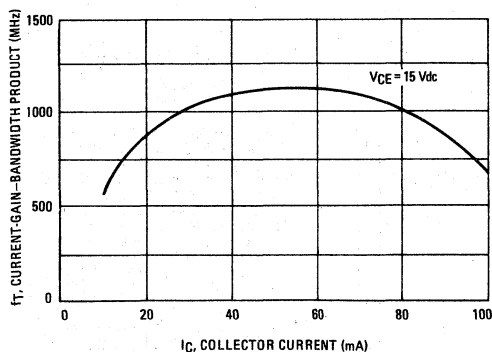
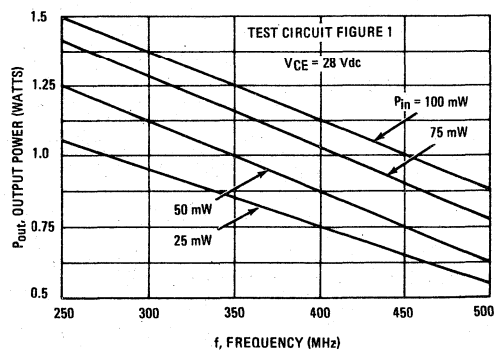


FIGURE 3 — OUTPUT POWER versus FREQUENCY



2N4957
2N4958
2N4959

The RF Line

PNP SILICON HIGH FREQUENCY TRANSISTORS

... designed for high-gain, low-noise amplifier, oscillator and mixer applications.

- Low Noise Figure @ 450 MHz –
 $N_F = 3.0$ dB (Max) – 2N4957
 $= 3.3$ dB (Max) – 2N4958
 $= 3.8$ dB (Max) – 2N4959
- High Power Gain @ 450 MHz –
 $G_{pe} = 17$ dB (Min) – 2N4957
 $= 16$ dB (Min) – 2N4958
 $= 15$ dB (Min) – 2N4959
- High Current-Gain-Bandwidth Product –
 $f_T = 1.2$ GHz (Min) @ $I_E = 2.0$ mAdc – 2N4957
 $= 1.0$ GHz (Min) @ $I_E = 2.0$ mAdc – 2N4958, 2N4959

1.2 GHz @ 2.0 mAdc – 2N4957
1.0 GHz @ 2.0 mAdc – 2N4958, 2N4959

HIGH FREQUENCY TRANSISTORS

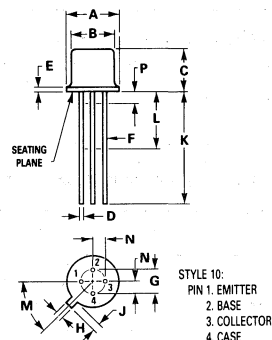
PNP SILICON



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current – Continuous	I_C	30	mAdc
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	200 1.14	mW mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

***ELECTRICAL CHARACTERISTICS** ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{Adc}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $T_A = 150^\circ\text{C}$)	I_{CBO}	— —	— —	0.1 100	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	20	40	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (1) ($I_E = 2.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 100\text{ MHz}$) 2N4957 2N4958, 2N4959	f_T	1200 1000	1600 1500	2500 2500	MHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{cb}	—	0.4	0.8	pF
Small-Signal Current Gain ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{fe}	20	—	200	—
Collector-Base Time Constant ($I_E = 2.0\text{ mAdc}$, $V_{CB} = 10\text{ Vdc}$, $f = 63.6\text{ MHz}$)	$r_b'C_c$	1.0	—	8.0	ps
Noise Figure ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 450\text{ MHz}$) 2N4957 2N4958 2N4959	NF	— — — —	— 2.6 2.9 3.2	— 3.0 3.3 3.8	dB
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 10\text{ Vdc}$, $I_C = 2.0\text{ mAdc}$, $f = 450\text{ MHz}$) 2N4957 2N4958 2N4959	G_{pe}	17 16 15	— — —	25 25 25	dB

*Indicates JEDEC Registered Data.

(1) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 — NOISE FIGURE AND POWER GAIN TEST CIRCUIT

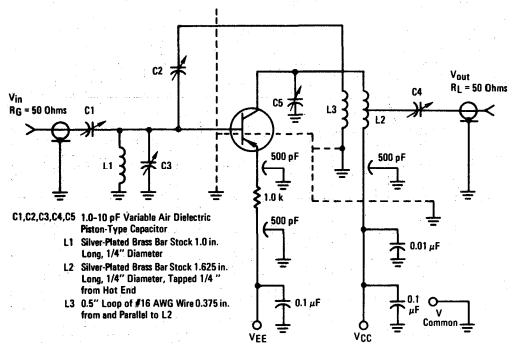


FIGURE 2 — UNILATERALIZED POWER GAIN versus FREQUENCY

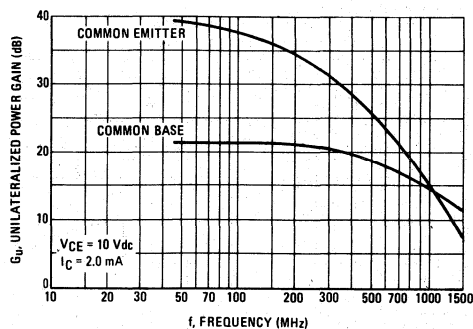


FIGURE 3 — NOISE FIGURE versus FREQUENCY

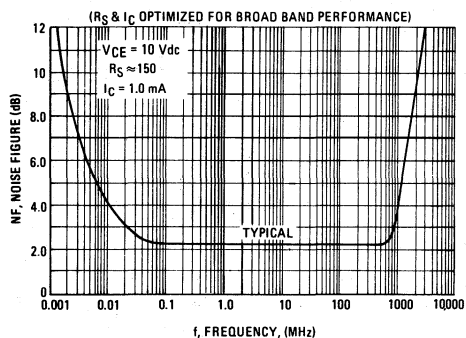


FIGURE 4 — NOISE FIGURE AND POWER GAIN versus COLLECTOR CURRENT

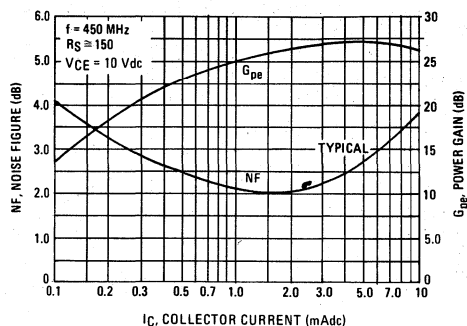


FIGURE 5 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

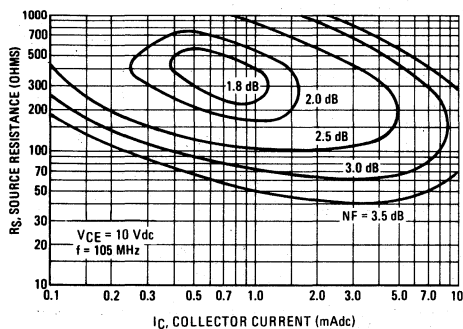
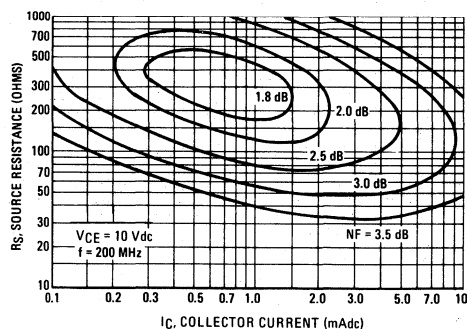
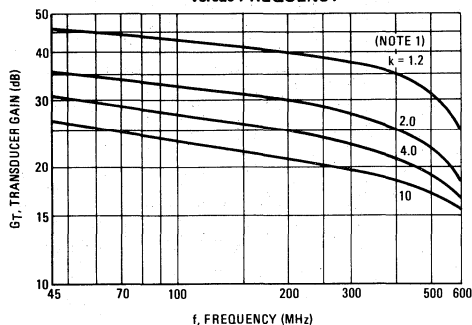
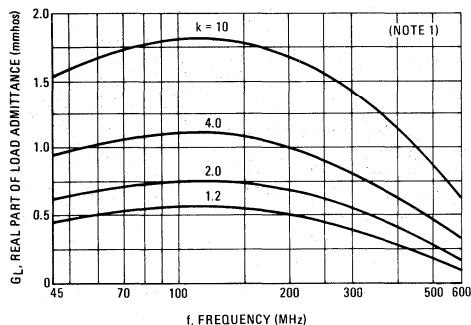
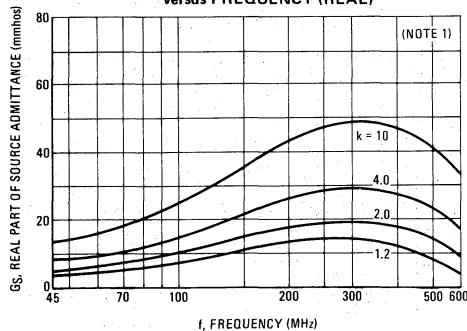


FIGURE 6 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT



COMMON EMITTER CIRCUIT DESIGN DATA

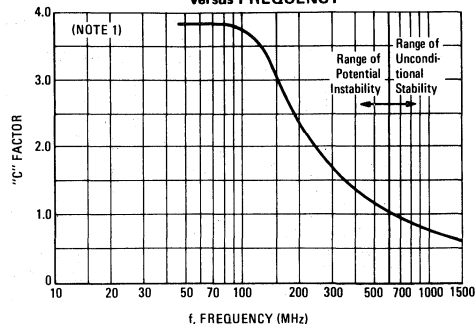
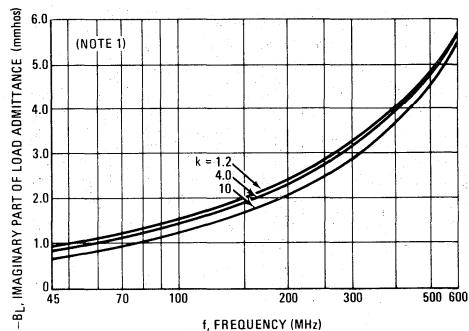
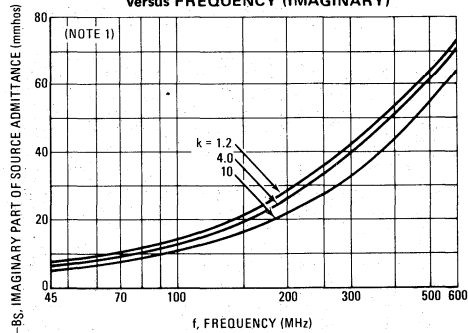
(V_{CE} = 10 Vdc, I_C = 2.0 mAdc)FIGURE 7 – TRANSDUCER GAIN
versus FREQUENCYFIGURE 9 – LOAD ADMITTANCE
versus FREQUENCY (REAL)FIGURE 11 – SOURCE ADMITTANCE
versus FREQUENCY (REAL)

NOTE 1

Figures 7 through 18 are included to assist the circuit designer in determining the stability of his particular circuit. Two stability criteria are given in these figures.

The Linvill "C" factor* is a measure of transistor stability when the input and output are terminated in the worst-case (open circuit) condition. When

* "Transistors and Active Circuits," Linvill and Gibbons, McGraw-Hill, 1961.

FIGURE 8 – LINVILL STABILITY FACTOR
versus FREQUENCYFIGURE 10 – LOAD ADMITTANCE
versus FREQUENCY (IMAGINARY)FIGURE 12 – SOURCE ADMITTANCE
versus FREQUENCY (IMAGINARY)

"C" is less than 1.0, the circuit is unconditionally stable. When "C" is greater than 1.0, the circuit is potentially unstable.

The Stern "K" factor† has been defined to determine the stability of a practical amplifier terminated in finite load and source admittances. If "K" is greater than 1.0, the circuit will be stable. If less than 1.0, the circuit will be unstable. For further details, see Application Note AN-215A.

† "Stability and Power Gain of Tuned Transistor Amplifiers," Arthur P. Stern, Proc. I.R.E., March 1967.

COMMON BASE CIRCUIT DESIGN DATA

($V_{CB} = 10 \text{ Vdc}$, $I_C = 2.0 \text{ mAdc}$)

FIGURE 13 – TRANSDUCER GAIN
versus FREQUENCY

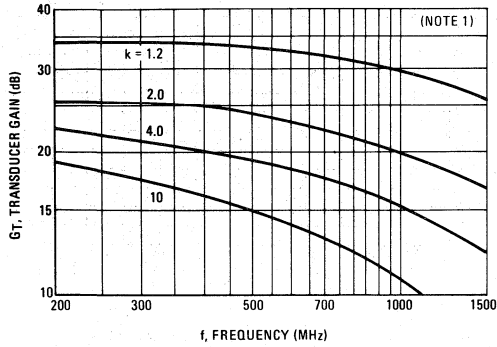


FIGURE 14 – LINVILL STABILITY FACTOR
versus FREQUENCY

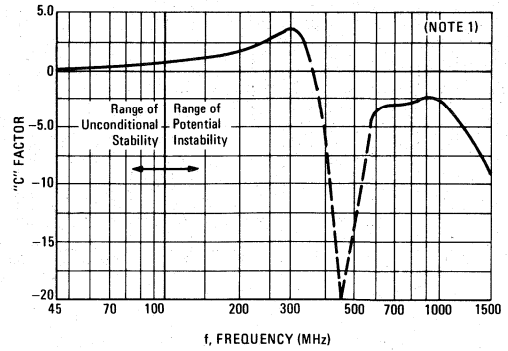


FIGURE 15 – LOAD ADMITTANCE
versus FREQUENCY (REAL)

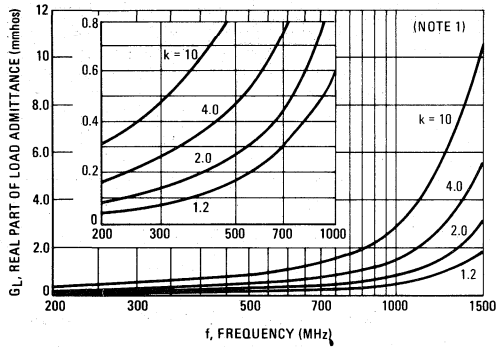


FIGURE 16 – LOAD ADMITTANCE
versus FREQUENCY (IMAGINARY)

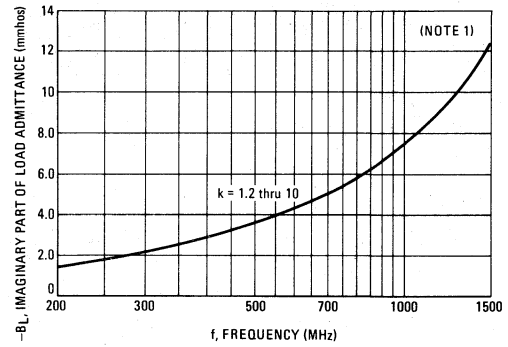


FIGURE 17 – SOURCE ADMITTANCE
versus FREQUENCY (REAL)

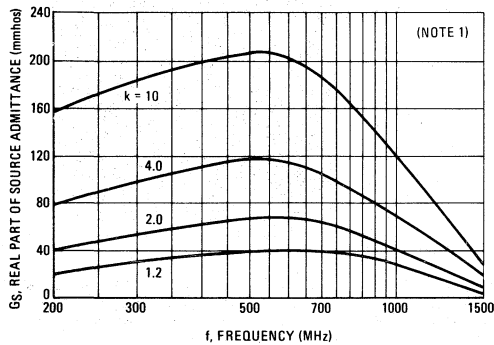


FIGURE 18 – SOURCE ADMITTANCE
versus FREQUENCY (IMAGINARY)

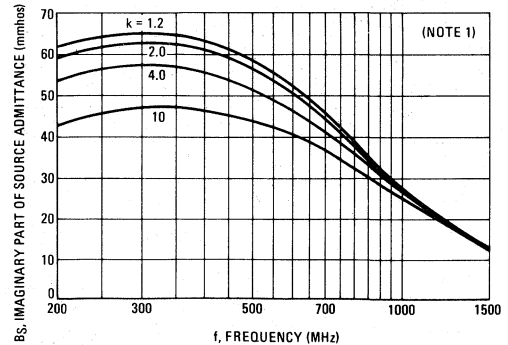


FIGURE 19 – SMALL-SIGNAL CURRENT GAIN
versus FREQUENCY

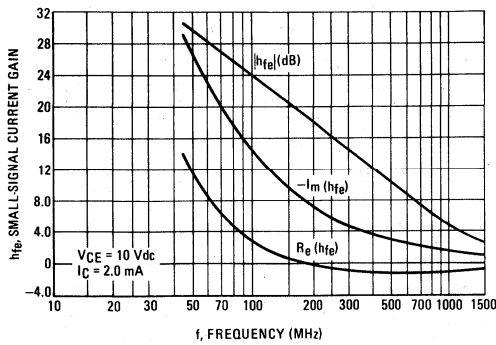


FIGURE 20 – POLAR h_{fe}

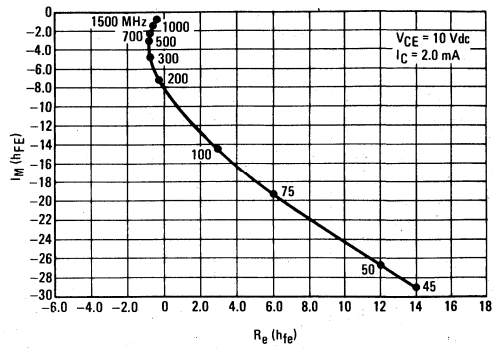


FIGURE 21 – f_T versus COLLECTOR CURRENT

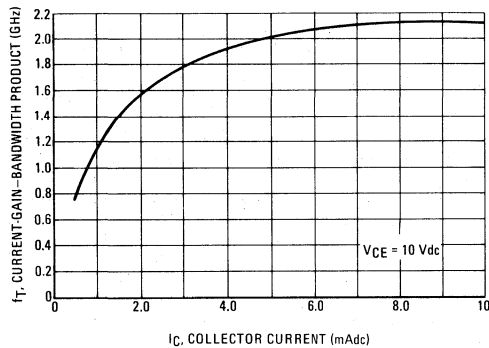


FIGURE 22 – DC CURRENT GAIN

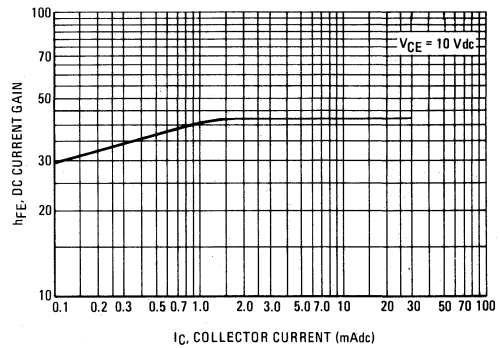


FIGURE 23 – CAPACITANCE

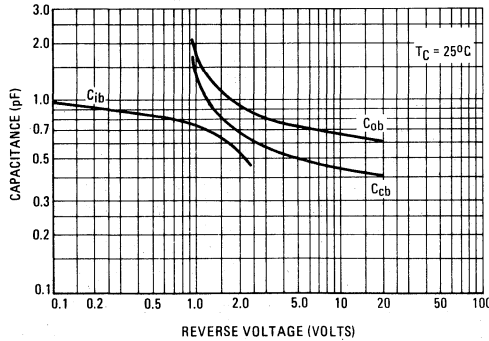
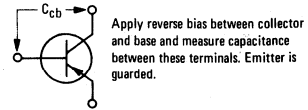
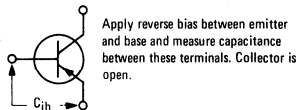
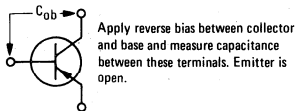
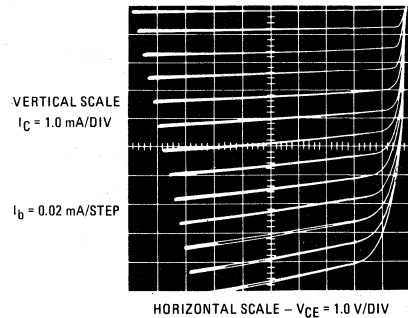


FIGURE 24 – COLLECTOR CHARACTERISTICS



Y PARAMETERS versus CURRENT (f = 450 MHz)

COMMON BASE

 $V_{CB} = 10 \text{ Vdc}$ ——— $V_{CB} = 15 \text{ Vdc}$ - - -

FIGURE 25 – INPUT ADMITTANCE

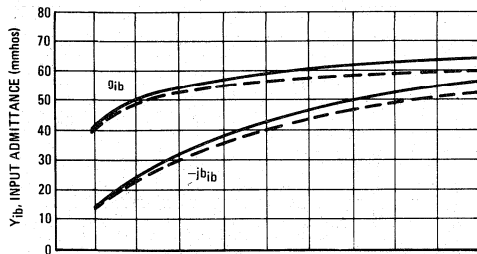


FIGURE 27 – FORWARD TRANSFER ADMITTANCE

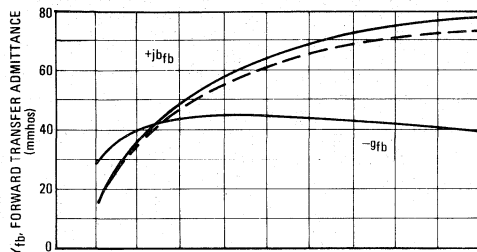


FIGURE 29 – OUTPUT ADMITTANCE

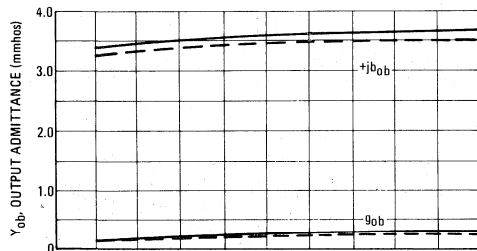
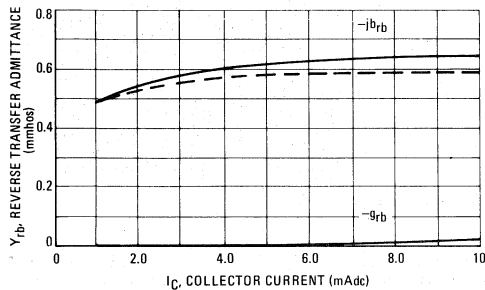


FIGURE 31 – REVERSE TRANSFER ADMITTANCE



COMMON EMITTER

 $V_{CE} = 10 \text{ Vdc}$ ——— $V_{CE} = 15 \text{ Vdc}$ - - -

FIGURE 26 – INPUT ADMITTANCE

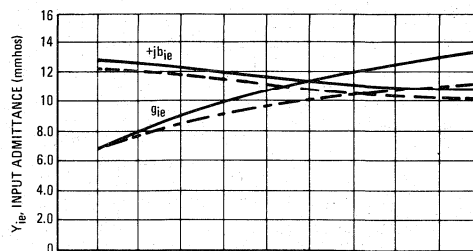


FIGURE 28 – FORWARD TRANSFER ADMITTANCE

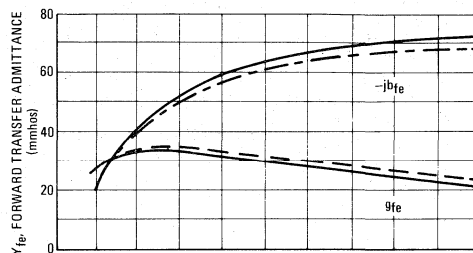


FIGURE 30 – OUTPUT ADMITTANCE

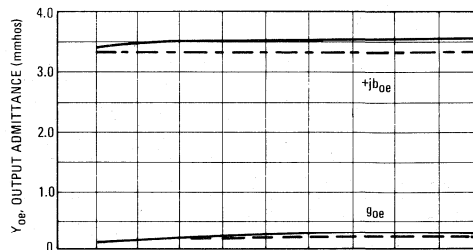
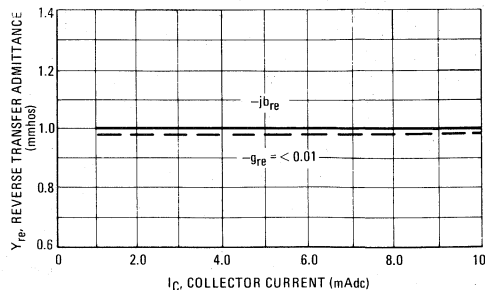
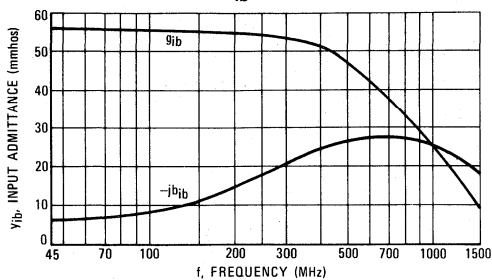
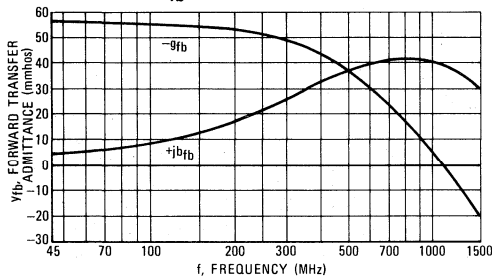
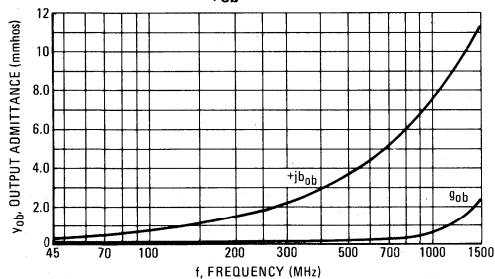
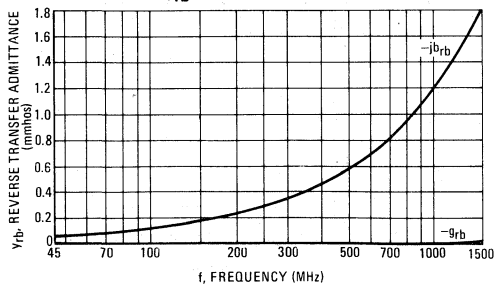
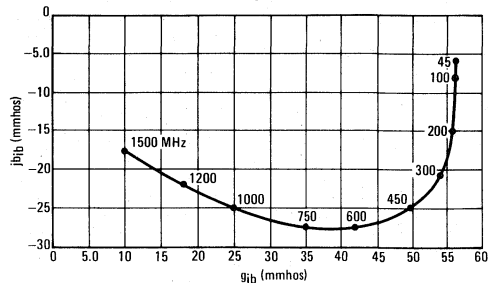
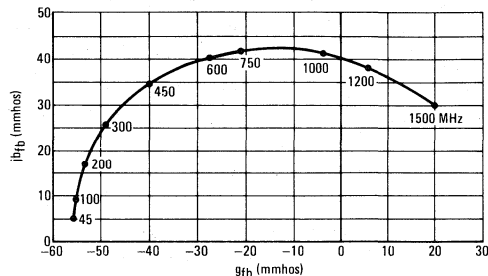
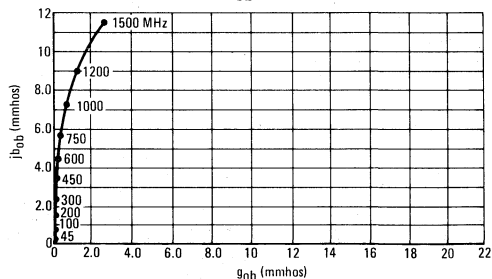
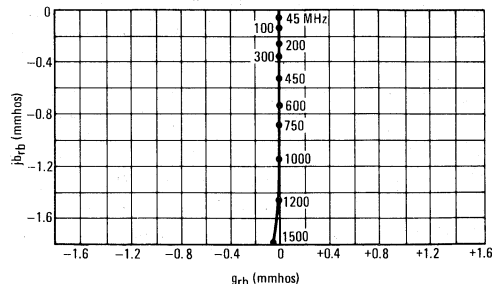


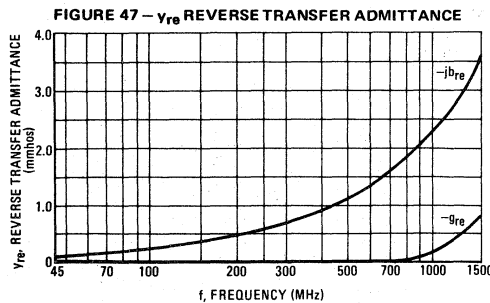
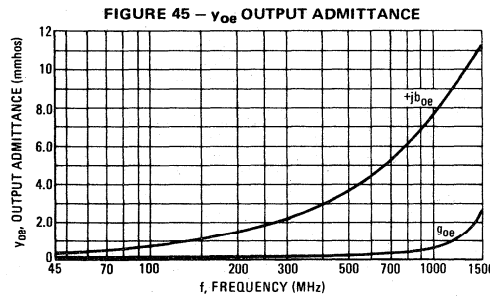
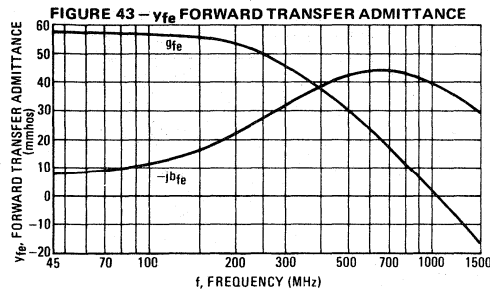
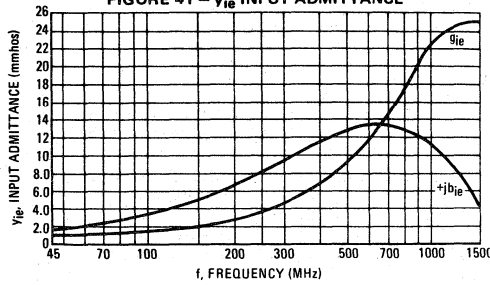
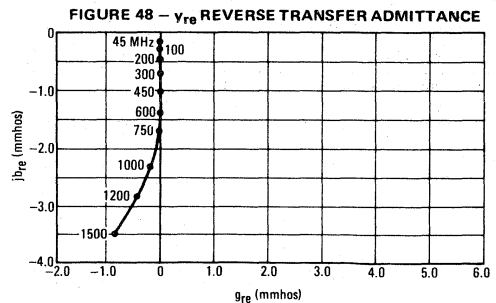
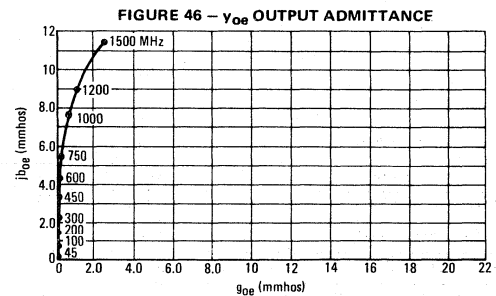
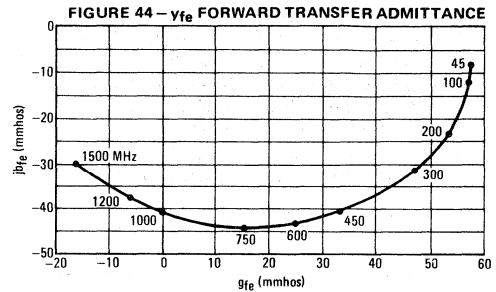
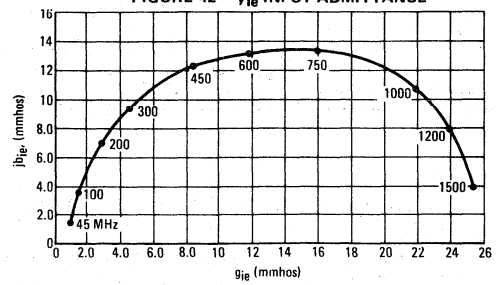
FIGURE 32 – REVERSE TRANSFER ADMITTANCE



COMMON BASE y PARAMETER VARIATIONS $(V_{CB} = 10 \text{ Vdc}, I_C = 2.0 \text{ mAdc})$ y PARAMETERS versus FREQUENCYFIGURE 33 — y_{ib} INPUT ADMITTANCEFIGURE 35 — y_{fb} FORWARD TRANSFER ADMITTANCEFIGURE 37 — y_{ob} OUTPUT ADMITTANCEFIGURE 39 — y_{rb} REVERSE TRANSFER ADMITTANCEPOLAR y PARAMETERS versus FREQUENCYFIGURE 34 — y_{ib} INPUT ADMITTANCEFIGURE 36 — y_{fb} FORWARD TRANSFER ADMITTANCEFIGURE 38 — y_{ob} OUTPUT ADMITTANCEFIGURE 40 — y_{rb} REVERSE TRANSFER ADMITTANCE

COMMON EMITTER y PARAMETER VARIATIONS

(VCE = 10 Vdc, IC = 2.0 mAdc)

 y PARAMETERS versus FREQUENCYFIGURE 41 – y_{ie} INPUT ADMITTANCEPOLAR y PARAMETERS versus FREQUENCYFIGURE 42 – y_{ie} INPUT ADMITTANCE

2N5031
2N5032

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers.

- High Current-Gain – Bandwidth Product –
 $f_T = 1000 \text{ MHz (Min) @ } I_C = 5.0 \text{ mA dc}$
- Low Noise Figure @ $f = 450 \text{ MHz}$ –
 $NF = 2.5 \text{ dB (Max) – 2N5031}$
 $= 3.0 \text{ dB (Max) – 2N5032}$
- High Power Gain –
 $G_{pe} = 14 \text{ dB (Min) @ } f = 450 \text{ MHz}$

2.5 dB @ 450 MHz – 2N5031
3.0 dB @ 450 MHz – 2N5032

**HIGH FREQUENCY
TRANSISTORS**

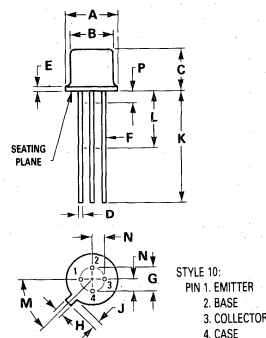
NPN SILICON



***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current – Continuous	I_C	20	mA dc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	200 1.14	mW mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
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E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC	—	0.100 BSC	—
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC	—	45° BSC	—
N	1.27 BSC	—	0.050 BSC	—
P	—	1.27	—	0.050

**CASE 20-03
TO-206AF
(ITO-72)**

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	V _{(BR)CEO}	10	—	—	Vdc
*Collector-Base Breakdown Voltage (I _C = 0.01 mAdc, I _E = 0)	V _{(BR)CBO}	15	—	—	Vdc
*Emitter-Base Breakdown Voltage (I _E = 0.01 mAdc, I _C = 0)	V _{(BR)EBO}	3.0	—	—	Vdc
*Collector Cutoff Current (V _{CE} = 6.0 Vdc, I _E = 0)	I _{CBO}	—	1.0	10	nAdc
ON CHARACTERISTICS					
*DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 6.0 Vdc)	h _{FE}	25	—	300	—
DYNAMIC CHARACTERISTICS					
*Current-Gain-Bandwidth Product (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 100 MHz)	f _T	1000	—	3500	MHz
*Output Capacitance (V _{CE} = 6.0 Vdc, I _E = 0, f = 0.1 MHz)	C _{cb}	—	1.3	1.5	pF
Collector-Base Time Constant (I _C = 6.0 mAdc, V _{CE} = 6.0 Vdc, f = 31.8 MHz)	τ _b C _c	—	5.0	—	ps
*Noise Figure (Figure 1) (I _C = 1.0 mAdc, V _{CE} = 6.0 Vdc, f = 450 MHz)	NF	—	—	2.5 3.0	dB
FUNCTIONAL TEST					
*Common-Emitter Amplifier Power Gain (Figure 1) (V _{CE} = 6.0 Vdc, I _C = 1.0 mAdc, f = 450 MHz)	G _{pe}	14	17	25	dB

*Indicates JEDEC Registered Data.
(1) Tuned for Minimum Noise.

FIGURE 1 — POWER GAIN AND NOISE FIGURE TEST CIRCUIT

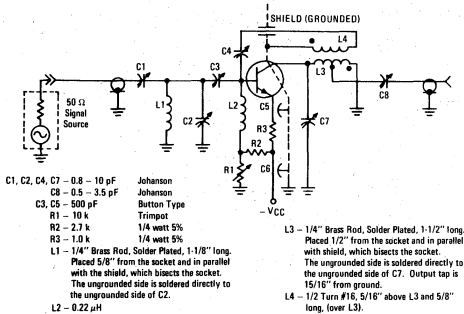


FIGURE 2 — COLLECTOR-BASE CAPACITANCE versus VOLTAGE

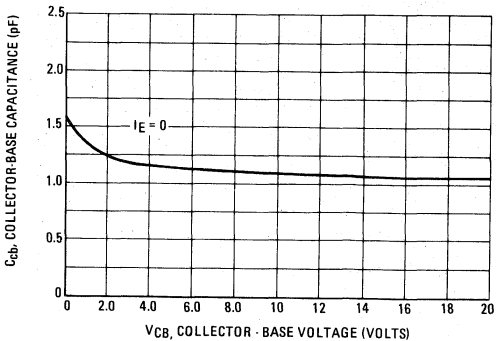


FIGURE 3 – CURRENT-GAIN-BANDWIDTH PRODUCT

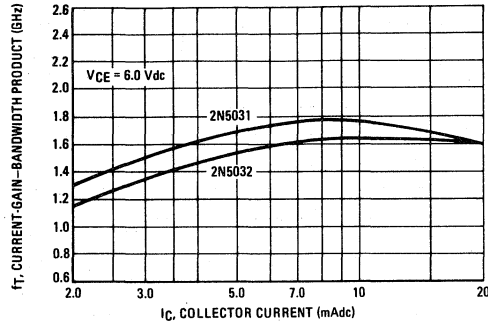


FIGURE 4 – S_{11} AND S_{22}

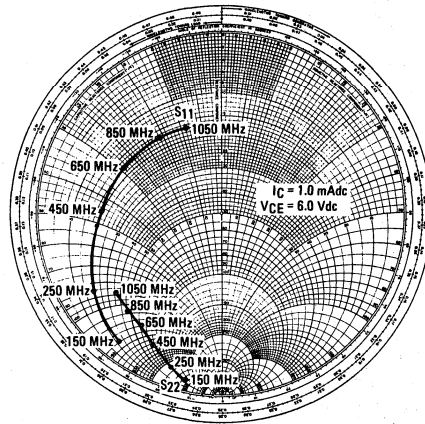


FIGURE 5 – S_{12}

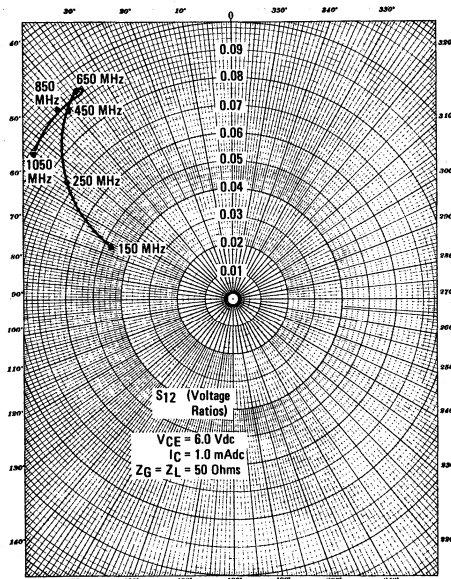


FIGURE 6 – S_{21}

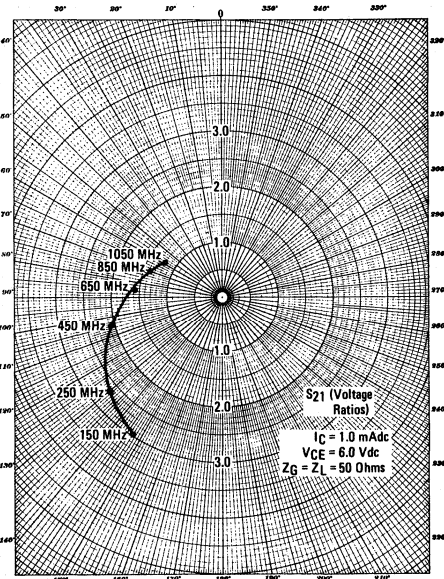


FIGURE 7 – NOISE FIGURE versus FREQUENCY

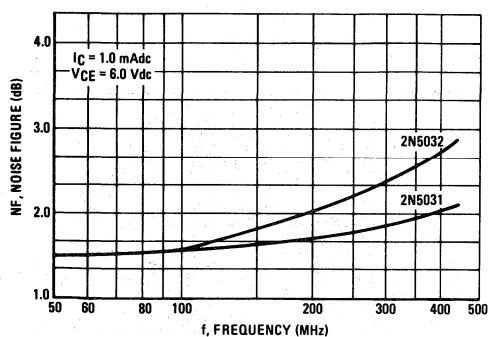


FIGURE 8 – POWER GAIN versus FREQUENCY

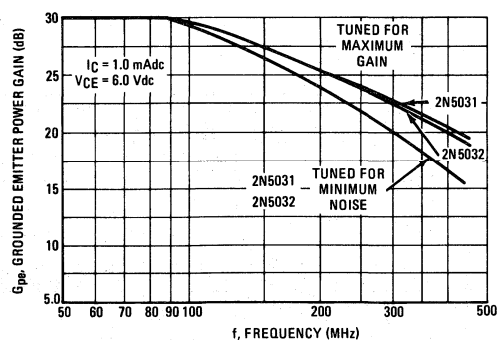


FIGURE 9 – INPUT ADMITTANCE versus FREQUENCY

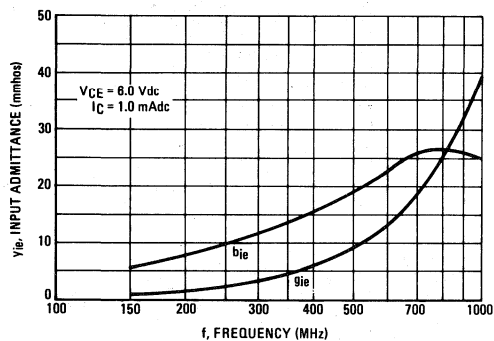


FIGURE 10 – OUTPUT ADMITTANCE versus FREQUENCY

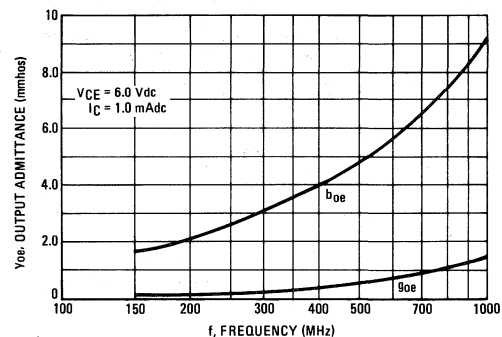


FIGURE 11 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

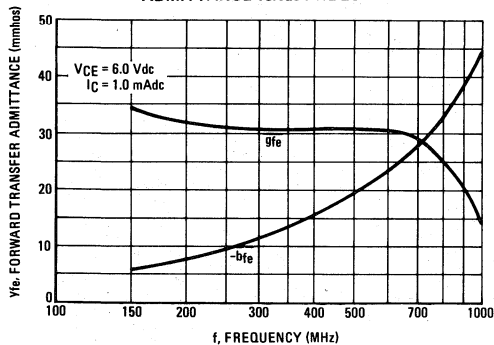
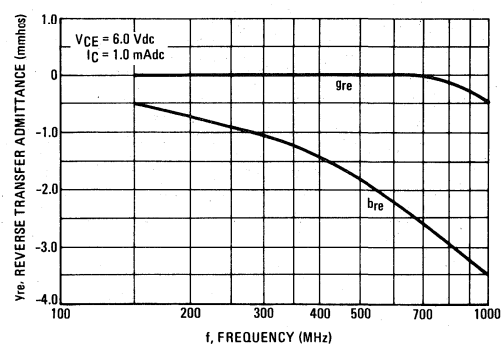


FIGURE 12 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY



The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

... designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output, driver, or pre-driver stages in UHF equipment and as a fundamental frequency oscillator at 1.68 GHz.

- Specified 1 GHz, 28 Vdc Characteristics —
 Output Power = 1.0 Watt
 Minimum Gain = 5.0 dB
 Efficiency = 35%
- Typical 1.68 GHz, 28 Vdc Characteristics —
 Output Power = 0.3 Watt
 Efficiency = 15%

MAXIMUM RATINGS

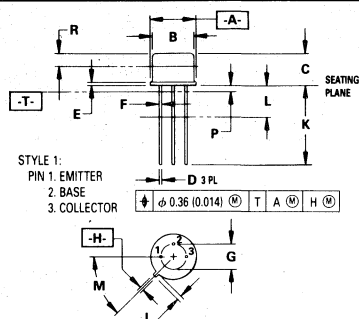
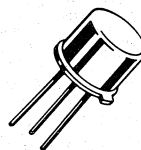
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	30	Vdc
*Collector-Emitter Voltage (R _{BE} = 10 Ohms)	V _{CER}	55	Vdc
*Collector-Base Voltage	V _{CB}	55	Vdc
*Emitter-Base Voltage	V _{EB}	3.0	Vdc
*Collector Current — Continuous	I _C	0.4	Adc
*Total Device Dissipation @ T _C = 25°C Derate above 25°C	P _D	3.5 0.02	Watts W/°C
*Storage Temperature Range	T _{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.

2N5108

1.0 W - 1 GHz
HIGH FREQUENCY
TRANSISTOR

NPN SILICON



NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.
- DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
- DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
- DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K. MINIMUM LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

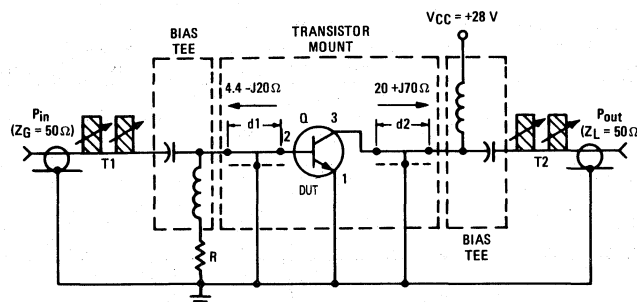
CASE 79-04
TO-205AD
(TO-39)

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Sustaining Voltage ($I_C = 5.0 \text{ mAdc}$, $R_{FE} = 10 \text{ ohms}$)	$V_{CE(sus)}$	55	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	55	—	—	Vdc
*Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
*Collector Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	20	μAdc
*Collector Cutoff Current ($V_{CE} = 50 \text{ Vdc}$, $V_{BE} = 0$) ($V_{CE} = 15 \text{ Vdc}$, $V_{BE} = 0$, $T_C = 150^\circ\text{C}$)	I_{CES}	— —	— —	1.0 10	μAdc mAdc
ON CHARACTERISTICS					
Collector-Emitter Saturation Voltage ($I_C = 100 \text{ mAdc}$, $I_B = 10 \text{ mAdc}$)	$V_{CE(sat)}$	—	—	0.5	Vdc
DYNAMIC CHARACTERISTICS					
*Current-Gain-Bandwidth Product ($I_C = 50 \text{ mAdc}$, $V_{CE} = 15 \text{ Vdc}$, $f = 200 \text{ MHz}$)	f_T	1200	—	—	MHz
*Output Capacitance ($V_{CB} = 30 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	1.3	3.0	pF
FUNCTIONAL TEST					
*Common-Emitter Amplifier Power Gain (Figure 1) ($P_{out} = 1.0 \text{ W}$, $V_{CC} = 28 \text{ Vdc}$, $I_C = 102 \text{ mAdc}$, $f = 1.0 \text{ GHz}$)	G_{PE}	5.0	—	—	dB
Power Output (Figure 1) ($P_{in} = 316 \text{ mW}$, $V_{CE} = 28 \text{ Vdc}$, $f = 1.0 \text{ GHz}$)	P_{out}	1.0	—	—	Watt
*Collector Efficiency ($P_{in} = 316 \text{ mW}$, $V_{CE} = 28 \text{ Vdc}$, $f = 1.0 \text{ GHz}$)	η	35	—	—	%
Power Output (Oscillator) (Figure 2) ($V_{CE} = 20 \text{ Vdc}$, $V_{EB} = 1.5 \text{ Vdc}$, $f = 1.68 \text{ GHz}$) (Minimum Efficiency = 15%)	P_{out}	—	0.3	—	Watt

* Indicates JEDEC Registered Data.

**FIGURE 1 – 1 GHz RF AMPLIFIER OUTPUT
POWER TEST CIRCUIT**



d1: 1" Input line, center conductor width = 0.280"

d2: 1" Output line, center conductor width = 0.125"

Q: 2N5108

R: 3.9 ohms

T1, T2: Microlab Double Stub Tuner, or Equivalent

Bias Tee: Microlab 08N, or Equivalent

Transistor Mount: 1/32" Microstrip board

Note: Impedance measurements are made at transistor socket pins.

**FIGURE 2 – 1.68 GHz RF OSCILLATOR OUTPUT
POWER TEST CIRCUIT**

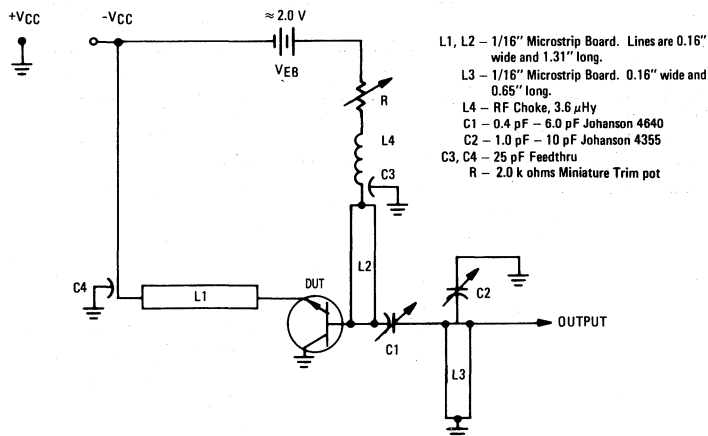


FIGURE 3 — OUTPUT POWER versus INPUT POWER

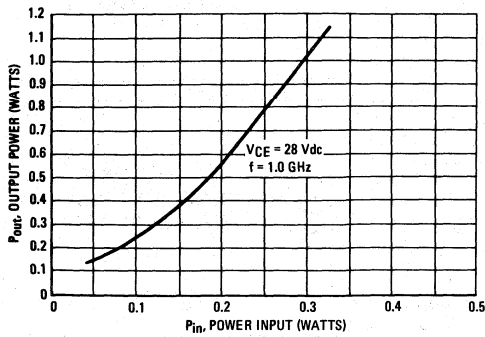
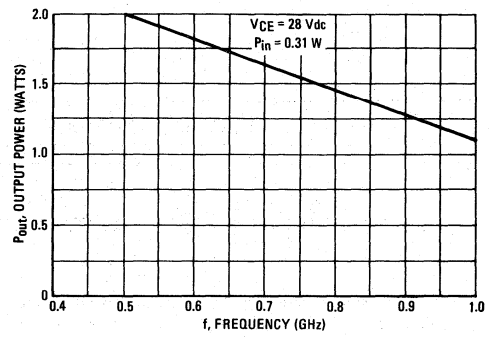
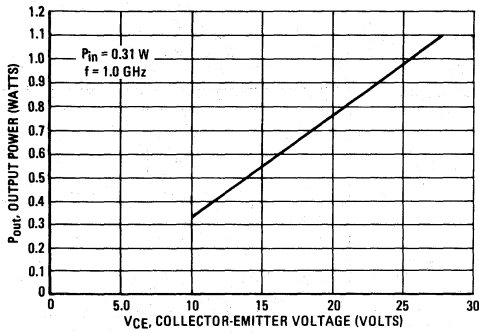
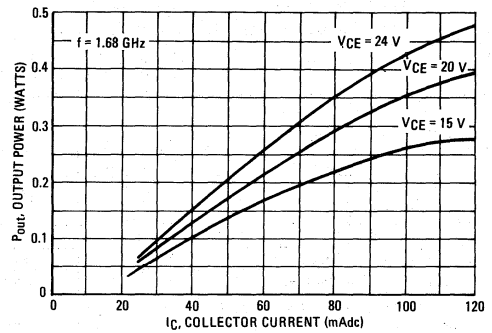
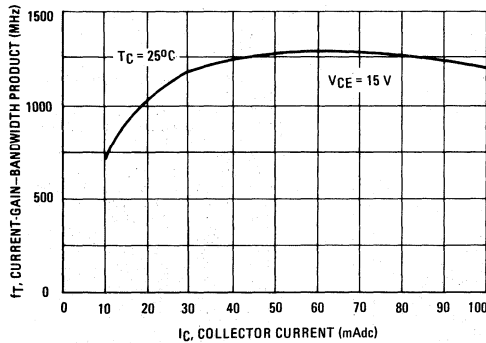
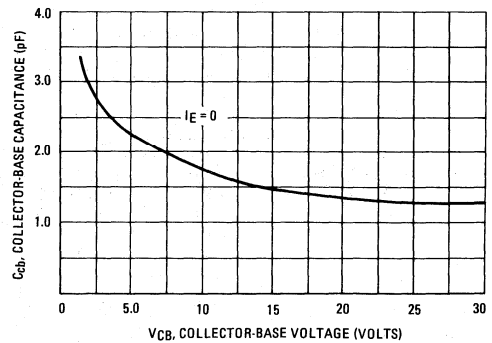


FIGURE 4 — OUTPUT POWER versus FREQUENCY

FIGURE 5 — OUTPUT POWER
versus COLLECTOR-EMITTER VOLTAGEFIGURE 6 — OSCILLATOR OUTPUT POWER
versus COLLECTOR CURRENTFIGURE 7 — CURRENT-GAIN-BANDWIDTH
PRODUCT versus CURRENTFIGURE 8 — COLLECTOR BASE
CAPACITANCE versus VOLTAGE

2N5109

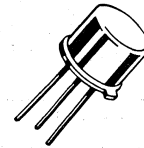
The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

... designed specifically for broadband applications requiring good linearity. Useable as a high frequency current mode switch to 200 mA.

- Low Noise Figure — @ $f = 200$ MHz
NF = 3.0 dB (Typ)
- High Current-Gain — Bandwidth Product —
 $f_T = 1200$ MHz (Min) @ $I_C = 50$ mA dc

1.2 GHz @ 50 mA dc
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



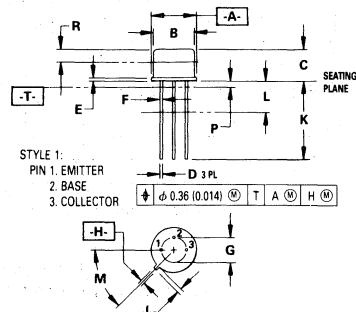
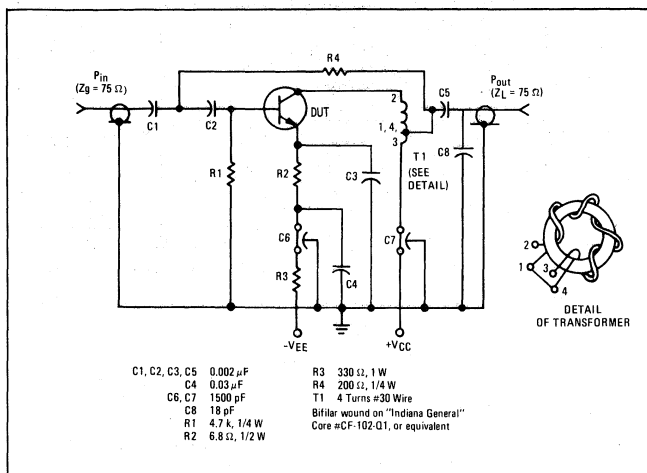
***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	20	Vdc
Collector-Base Voltage	V_{CB0}	40	Vdc
Emitter-Base Voltage	V_{EB0}	3.0	Vdc
Base Current — Continuous	I_B	400	mA dc
Collector Current — Continuous	I_C	400	mA dc
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ (1 Derate above 25°C)	P_D	2.5	Watt
		20	mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

(1) Total Device Dissipation at $T_A = 25^\circ\text{C}$ is 1.0 Watt.

• Indicates JEDEC Registered Data.

FIGURE 1 — RF AMPLIFIER FOR VOLTAGE GAIN TEST CIRCUIT



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage ($I_C = 5.0 \text{ mA}_{dc}$, $I_B = 0$)	$V_{CEO(sus)}$	20	—	—	V _{dc}
Collector-Emitter Sustaining Voltage (1) ($I_C = 5.0 \text{ mA}_{dc}$, $R_{BE} = 10 \Omega$)	$V_{CER(sus)}$	40	—	—	V _{dc}
Collector Cutoff Current ($V_{CE} = 15 \text{ V}_{dc}$, $I_B = 0$)	I_{CEO}	—	—	20	μA_{dc}
Collector Cutoff Current ($V_{CE} = 15 \text{ V}_{dc}$, $V_{BE} = -1.5 \text{ V}$, $T_C = 150^\circ\text{C}$)	I_{CEX}	—	—	5.0	mA_{dc}
($V_{CE} = 35 \text{ V}_{dc}$, $V_{BE} = -1.5 \text{ V}$)		—	—	5.0	mA_{dc}
Emitter Cutoff Current ($V_{BE} = 3.0 \text{ V}_{dc}$, $I_C = 0$)	I_{EBO}	—	—	100	μA_{dc}
ON CHARACTERISTICS					
DC Current Gain ($I_C = 360 \text{ mA}_{dc}$, $V_{CE} = 5.0 \text{ V}_{dc}$)	h_{FE}	5.0	—	—	—
($I_C = 50 \text{ mA}_{dc}$, $V_{CE} = 15 \text{ V}_{dc}$)		40	—	120	—
DYNAMIC CHARACTERISTICS					
*Current-Gain — Bandwidth Product ($I_C = 50 \text{ mA}_{dc}$, $V_{CE} = 15 \text{ V}_{dc}$, $f = 200 \text{ MHz}$)	f_T	1200	—	—	MHz
*Collector-Base Capacitance ($V_{CB} = 15 \text{ V}_{dc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{cb}	—	1.8	3.5	pF
Noise Figure ($I_C = 10 \text{ mA}_{dc}$, $V_{CE} = 15 \text{ V}_{dc}$, $f = 200 \text{ MHz}$) (Figure 2)	NF	—	3.0	—	dB
FUNCTIONAL TEST					
*Common-Emitter Amplifier Voltage Gain (Figure 1) ($I_C = 50 \text{ mA}_{dc}$, $V_{CC} = 15 \text{ V}_{dc}$, $f = 50$ to 216 MHz)	G_{ve}	11	—	—	dB
*Power Input (Figure 2) ($I_C = 50 \text{ mA}_{dc}$, $V_{CC} = 15 \text{ V}_{dc}$, $R_S = 50 \text{ ohms}$, $P_{out} = 1.26 \text{ mW}$, $f = 200 \text{ MHz}$)	P_{in}	—	—	0.1	mW

* Indicates JEDEC Registered Data.
(1) Pulsed thru a 25 mH Inductor; 50% Duty Cycle

FIGURE 2 — 200 MHz TEST CIRCUIT

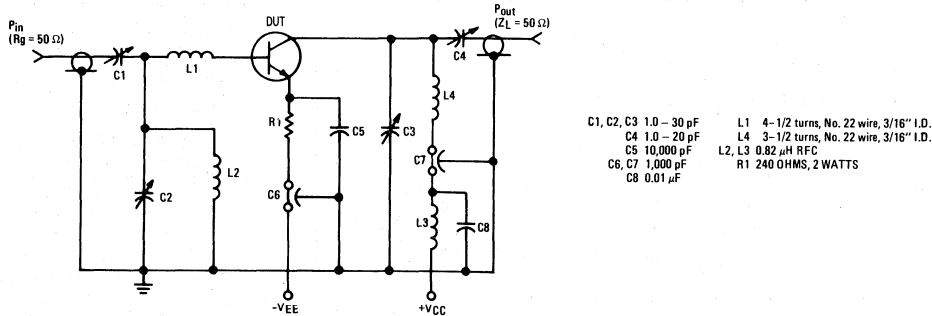


FIGURE 3 – CURRENT-GAIN – BANDWIDTH PRODUCT

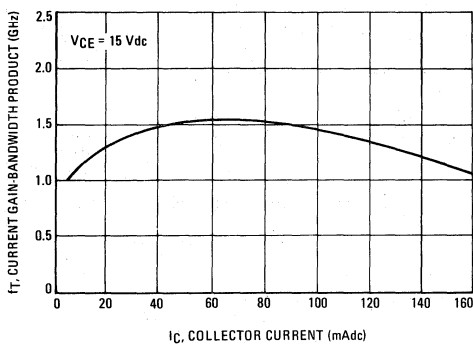


FIGURE 4 – COLLECTOR-BASE TIME CONSTANT

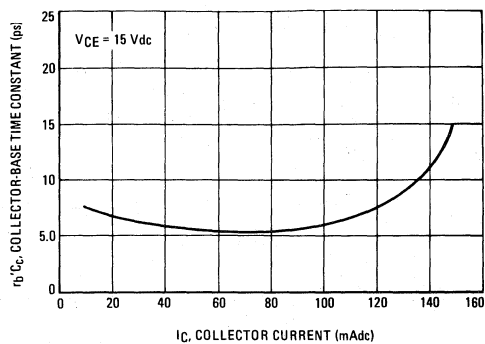


FIGURE 5 – SATURATION VOLTAGES

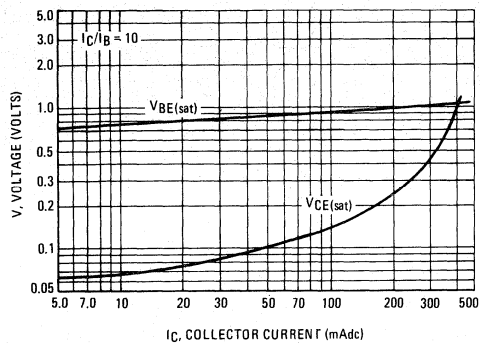


FIGURE 6 – CAPACITANCES versus REVERSE VOLTAGE

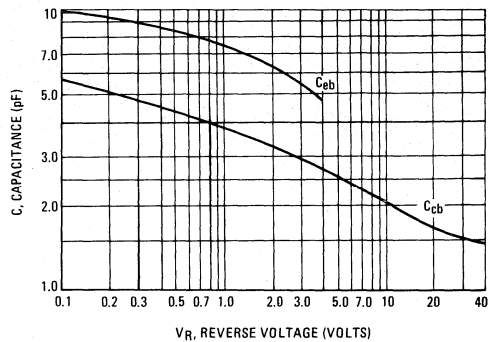


FIGURE 7 – INPUT ADMITTANCE versus FREQUENCY

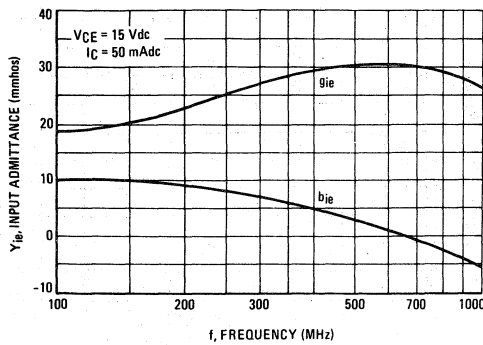


FIGURE 8 – INPUT ADMITTANCE versus COLLECTOR CURRENT

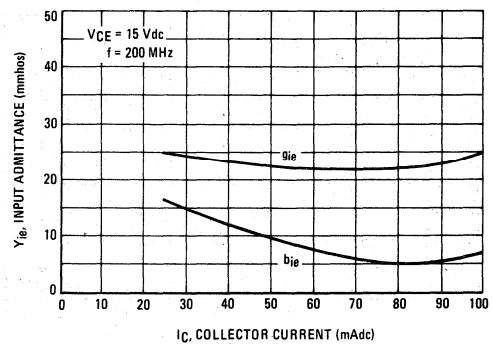


FIGURE 9 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY

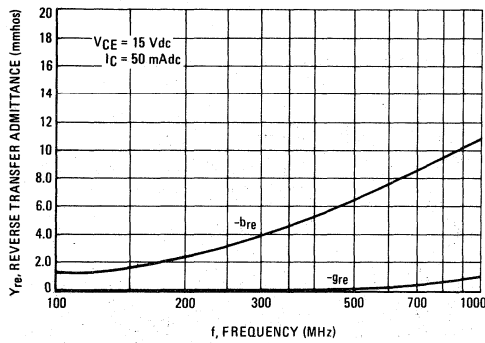


FIGURE 10 – REVERSE TRANSFER ADMITTANCE versus COLLECTOR CURRENT

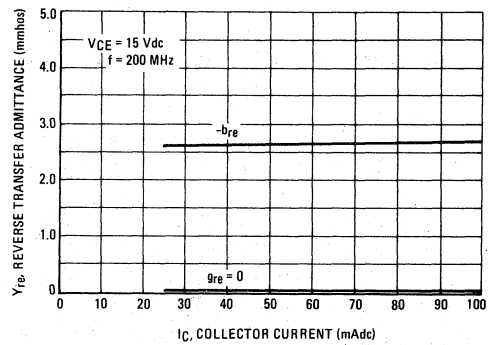


FIGURE 11 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

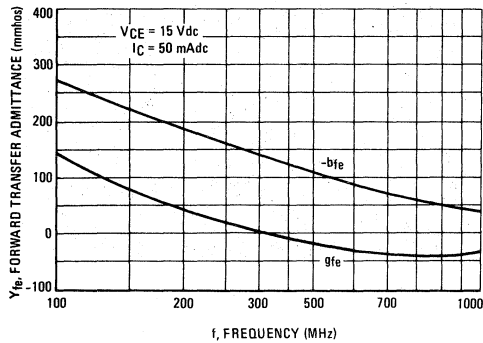


FIGURE 12 – FORWARD TRANSFER ADMITTANCE versus COLLECTOR CURRENT

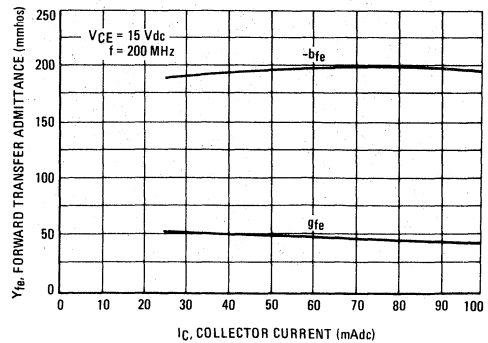


FIGURE 13 – OUTPUT ADMITTANCE versus FREQUENCY

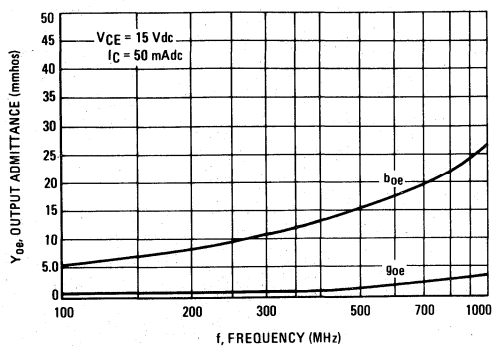


FIGURE 14 – OUTPUT ADMITTANCE versus COLLECTOR CURRENT

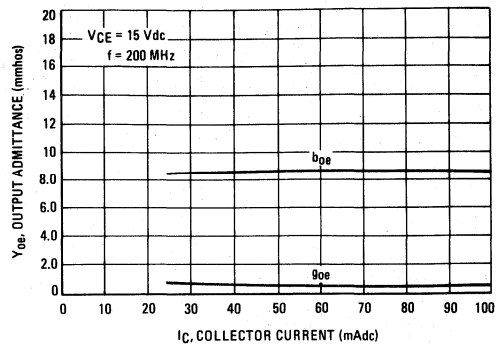


FIGURE 15 – INPUT REFLECTION COEFFICIENT versus FREQUENCY

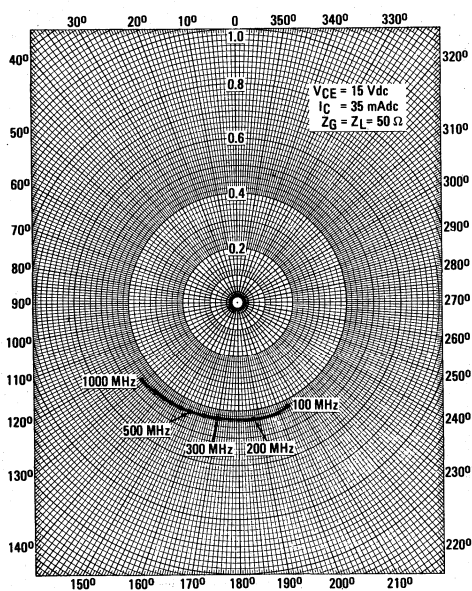


FIGURE 16 – OUTPUT REFLECTION COEFFICIENT versus FREQUENCY

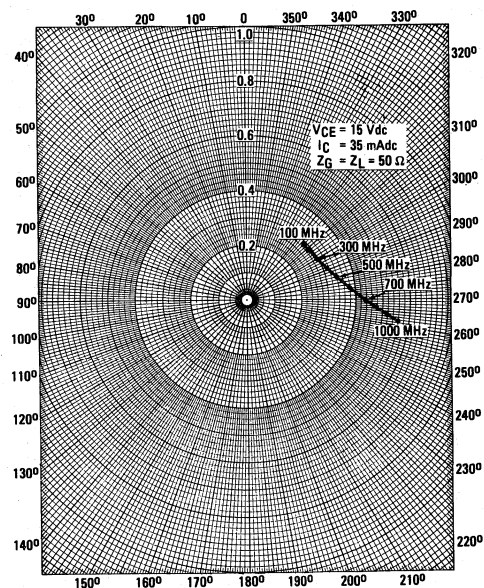


FIGURE 17 — REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY

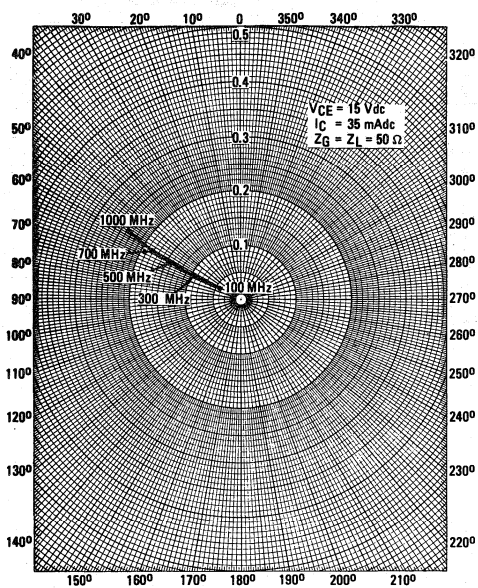


FIGURE 18 — FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY

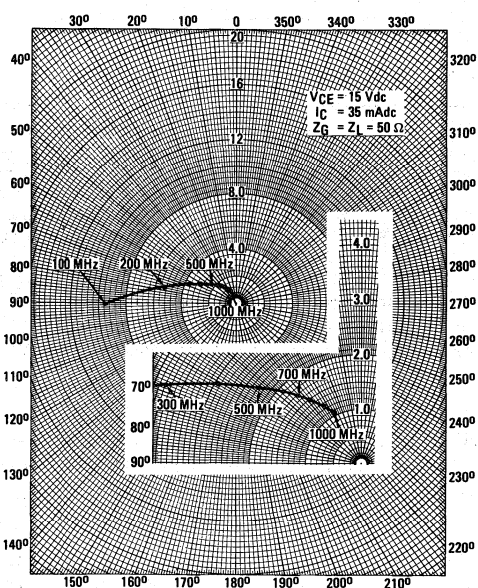
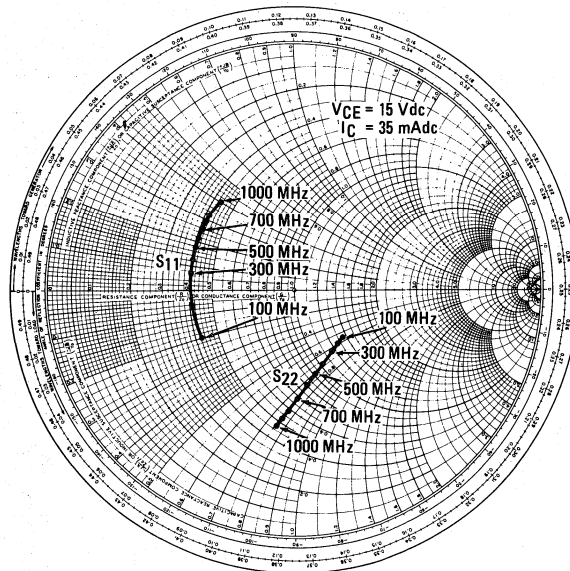


FIGURE 19 — INPUT REFLECTION COEFFICIENT AND OUTPUT REFLECTION COEFFICIENT versus FREQUENCY



The RF Line

PNP SILICON RF POWER TRANSISTOR

... designed for amplifier, frequency multiplier or oscillator applications in military and industrial equipment. Suitable for use as Class A, B, or C output driver, or pre-driver stages in VHF and UHF.

- High Power Gain — $G_{PE} = 8.0 \text{ dB (Min)} @ f = 400 \text{ MHz}$,
14.5 dB (Typ) @ 175 MHz — No Emitter Tuning
- Power Output — $P_{out} = 1.0 \text{ Watt (Min)} @ f = 400 \text{ MHz}$
1.5 Watt (Typ) @ $f = 175 \text{ MHz}$
- Resists Burnout When Load is Shorted or Opened
- Designed for Use in Complementary Circuits with 2N3866

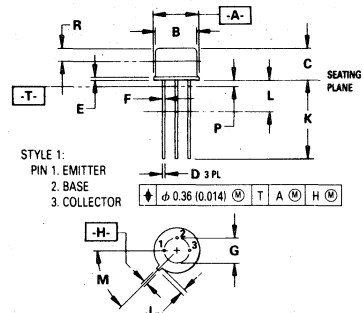
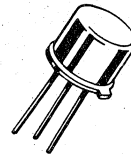
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	60	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current	I_C	0.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.

2N5160

**PNP SILICON
AMPLIFIER
TRANSISTOR**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
 4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
 5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.29	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35		0.250	
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

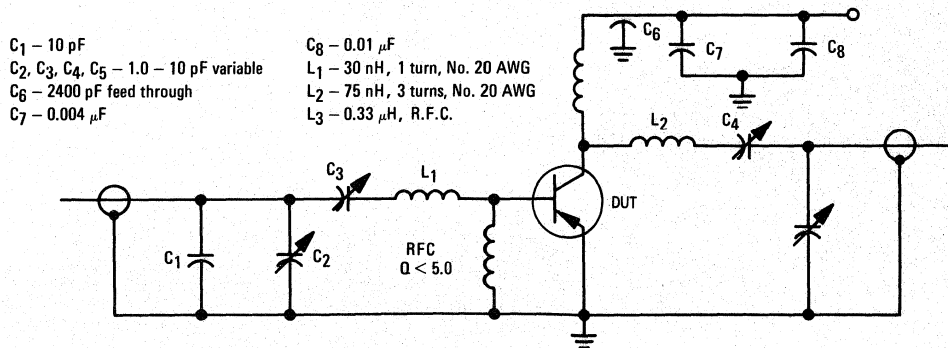
**CASE 79-04
TO-205AD
(TO-39)**

***ELECTRICAL CHARACTERISTICS** ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage ($I_C = 5.0\text{ mAdc}$, $I_B = 0$)	$V_{CEO(sus)}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO(sus)}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	20	μAdc
Collector Cutoff Current ($V_{CE} = 60\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	0.1	mAdc
Collector Cutoff Current ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product ($I_C = 50\text{ mAdc}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	500	900	—	MHz
Collector-Base Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ to }1.0\text{ MHz}$)	C_{cb}	—	2.5	4.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ Vdc}$, $P_{in} = 0.16\text{ Watt}$, $f = 400\text{ MHz}$) ($V_{CE} = 28\text{ Vdc}$, $P_{in} = 50\text{ mW}$, $f = 175\text{ MHz}$)	G_{PE}	8.0 —	8.8 14.5	—	dB
Power Output ($V_{CE} = 28\text{ Vdc}$, $P_{in} = 0.16\text{ Watt}$, $f = 400\text{ MHz}$) ($V_{CE} = 28\text{ Vdc}$, $P_{in} = 50\text{ mW}$, $f = 175\text{ MHz}$)	P_{out}	1.0 —	1.2 1.4	—	Watt
Collector Efficiency ($V_{CE} = 28\text{ Vdc}$, $P_{in} = 0.16\text{ Watt}$, $f = 400\text{ MHz}$)	η	45	55	—	%

*Indicates JEDEC Registered Data.

FIGURE 1 — 400-MHz TEST CIRCUIT



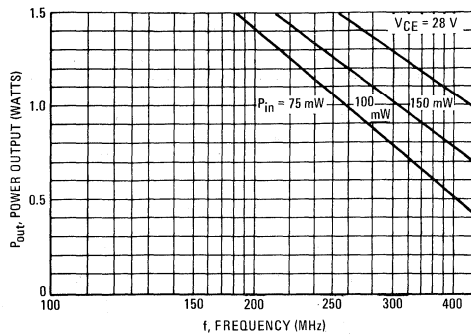
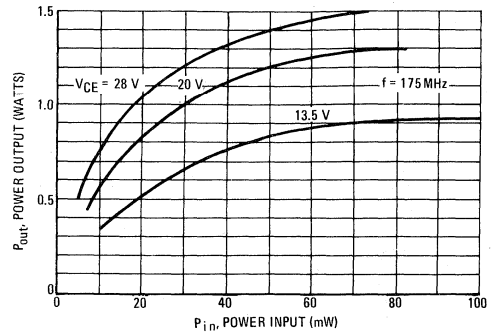
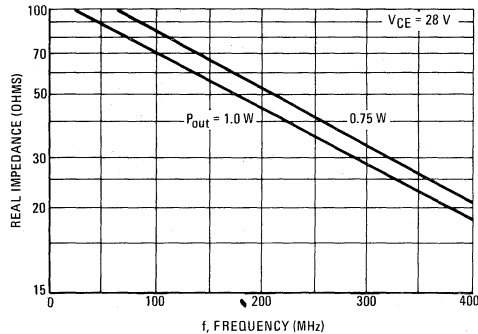
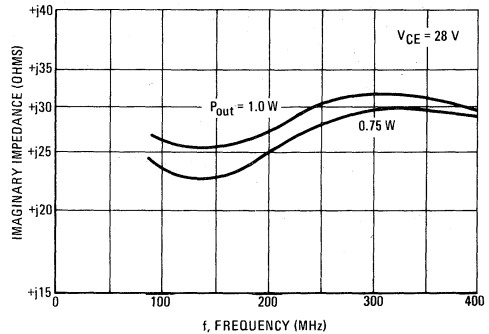
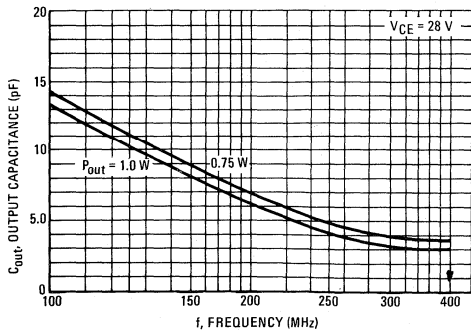
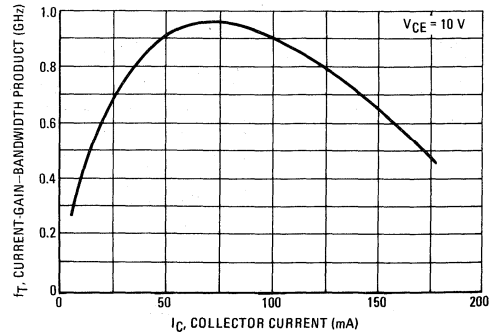
**FIGURE 2 – POWER OUTPUT
versus FREQUENCY**

**FIGURE 3 – POWER OUTPUT
versus POWER INPUT**

**FIGURE 4 – PARALLEL INPUT
IMPEDANCE versus FREQUENCY**

**FIGURE 5 – PARALLEL INPUT
IMPEDANCE versus FREQUENCY**

**FIGURE 6 – PARALLEL OUTPUT
CAPACITANCE versus FREQUENCY**

**FIGURE 7 – CURRENT-GAIN-BANDWIDTH
PRODUCT versus COLLECTOR CURRENT**


FIGURE 8 – 2N5160 300-MHz COMPLEMENTARY POWER OUTPUT CIRCUIT

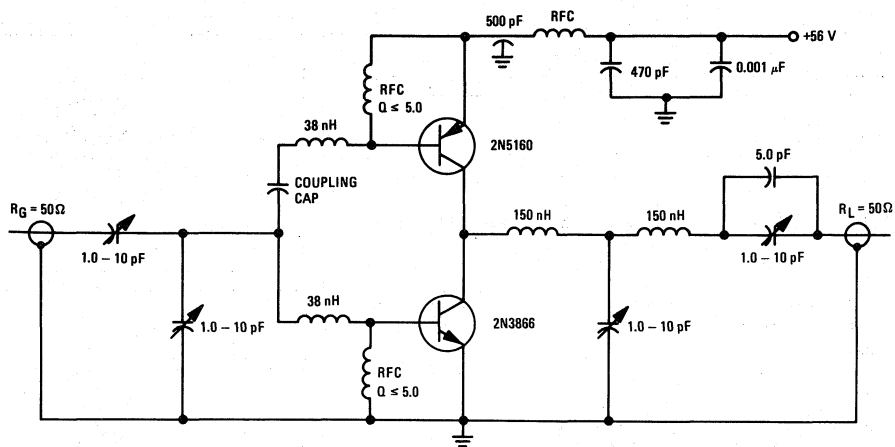
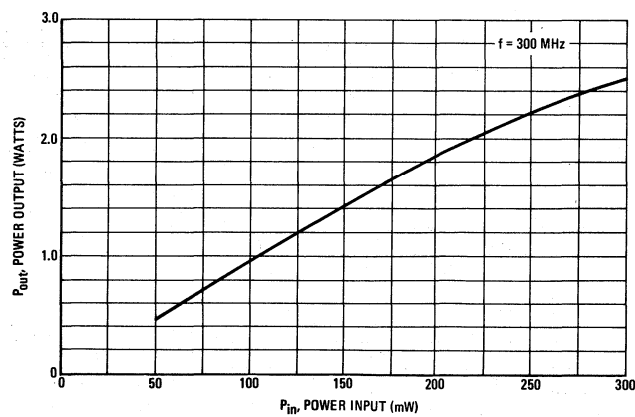


FIGURE 9 – COMPLEMENTARY CIRCUIT – POWER OUTPUT versus POWER INPUT



The RF Line

NPN SILICON RF HIGH FREQUENCY TRANSISTOR

... designed primarily for use in high-gain, low-noise amplifier, oscillator, and mixer applications. Can also be used in UHF converter applications.

- High Current-Gain — Bandwidth Product —
 $f_T = 1.4 \text{ GHz (Typ) @ } I_C = 10 \text{ mAdc}$
- Low Collector-Base Time Constant —
 $\tau_b' C_C = 14 \text{ ps (Max) @ } I_E = 2.0 \text{ mAdc}$
- Characterized with Scattering Parameters
- Low Noise Figure —
 $NF = 4.5 \text{ dB (Max) @ } f = 200 \text{ MHz}$

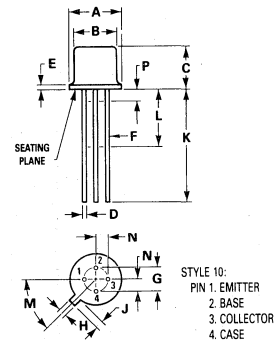
***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage Applicable 1.0 to 20 mAdc	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CB}	20	Vdc
Emitter-Base Voltage	V_{EB}	2.5	Vdc
Collector Current	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	200 1.14	mW mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	300 1.71	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

2N5179

4.5 dB @ 200 MHz
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

*ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Sustaining Voltage ($I_C = 3.0\text{ mAdc}$, $I_B = 0$)	$V_{CE0(sus)}$	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.001\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.01\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	2.5	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $T_A = 150^\circ\text{C}$)	I_{CBO}	— —	0.02 1.0	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 3.0\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$)	h_{FE}	25	250	—
Collector-Emitter Saturation Voltage ($I_C = 10\text{ mAdc}$, $I_B = 1.0\text{ mAdc}$)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage ($I_C = 10\text{ mAdc}$, $I_B = 1.0\text{ mAdc}$)	$V_{BE(sat)}$	—	1.0	Vdc

DYNAMIC CHARACTERISTICS

Current-Gain — Bandwidth Product ① ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 100\text{ MHz}$)	f_T	900	2000	MHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 0.1$ to 1.0 MHz)	C_{cb}	—	1.0	pF
Small-Signal Current Gain ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{fe}	25	300	—
Collector-Base Time Constant ($I_E = 2.0\text{ mAdc}$, $V_{CB} = 6.0\text{ Vdc}$, $f = 31.9\text{ MHz}$)	$r_b' C_c$	3.0	14	ps
Noise Figure (See Figure 1) ($I_C = 1.5\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$, $R_S = 50\text{ ohms}$, $f = 200\text{ MHz}$)	NF	—	4.5	dB

FUNCTIONAL TEST

Common-Emitter Amplifier Power Gain (See Figure 1) ($V_{CE} = 6.0\text{ Vdc}$, $I_C = 5.0\text{ mAdc}$, $f = 200\text{ MHz}$)	G_{pe}	15	—	dB
Power Output (See Figure 2) ($V_{CB} = 10\text{ Vdc}$, $I_E = 12\text{ mAdc}$, $f \geq 500\text{ MHz}$)	P_{out}	20	—	mW

*Indicates JEDEC Registered Values.

① f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 — 200 MHz AMPLIFIER POWER GAIN AND NOISE FIGURE CIRCUIT

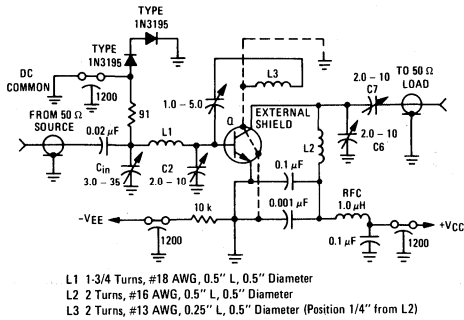


FIGURE 2 — 500 MHz OSCILLATOR CIRCUIT

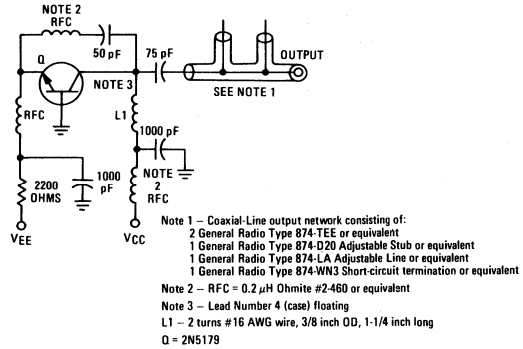


FIGURE 3 — NOISE FIGURE versus FREQUENCY

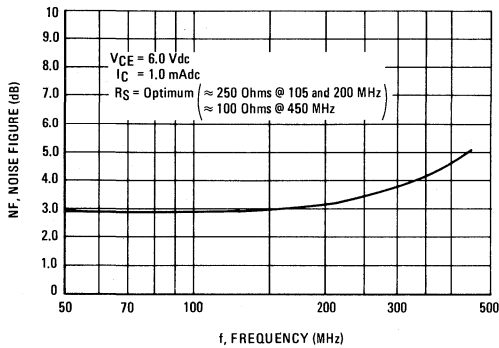


FIGURE 4 — NOISE FIGURE versus SOURCE RESISTANCE and COLLECTOR CURRENT

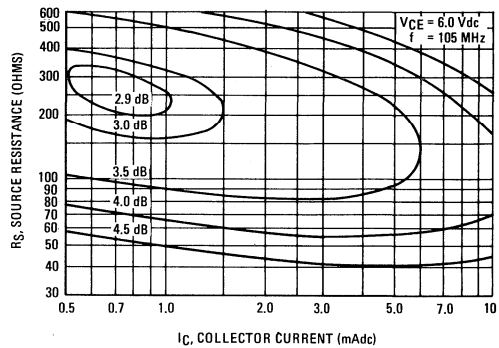


FIGURE 5 — NOISE FIGURE versus SOURCE RESISTANCE and COLLECTOR CURRENT

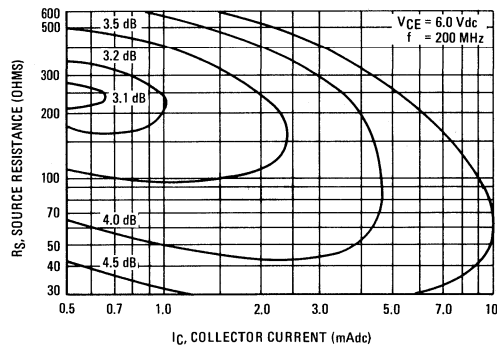


FIGURE 6 – CURRENT-GAIN-BANDWIDTH PRODUCT

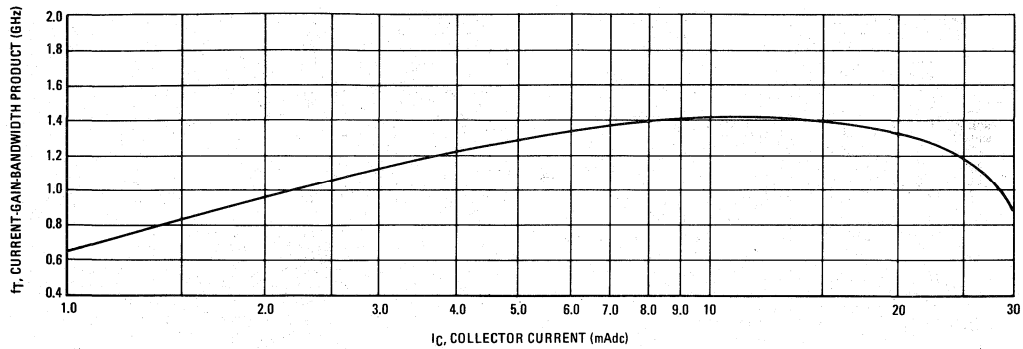
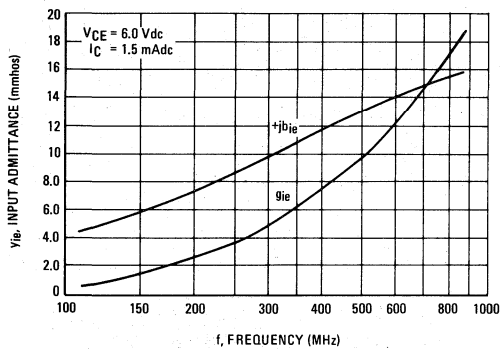
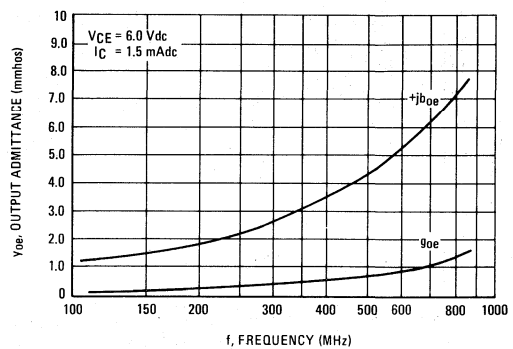
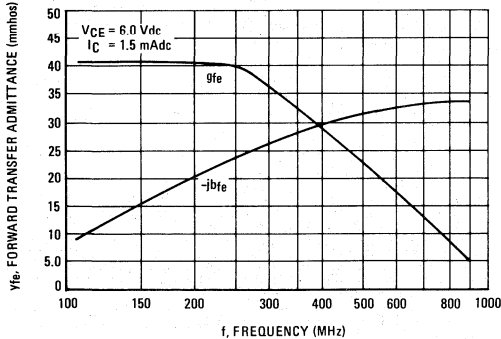
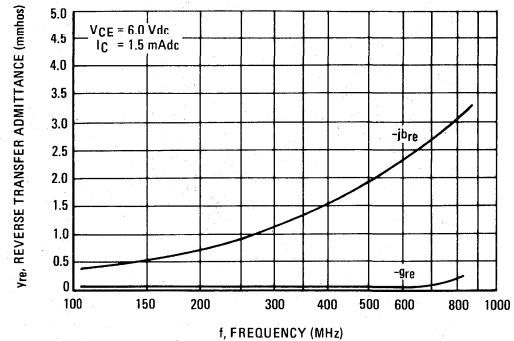
FIGURE 7 – INPUT ADMITTANCE
versus FREQUENCYFIGURE 8 – OUTPUT ADMITTANCE
versus FREQUENCYFIGURE 9 – FORWARD TRANSFER
ADMITTANCE versus FREQUENCYFIGURE 10 – REVERSE TRANSFER
ADMITTANCE versus FREQUENCY

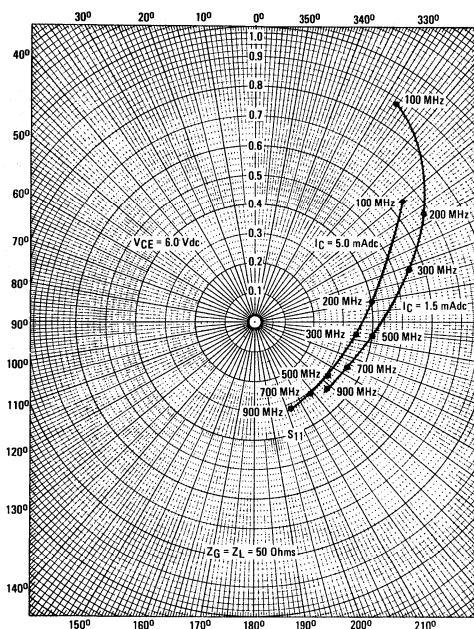
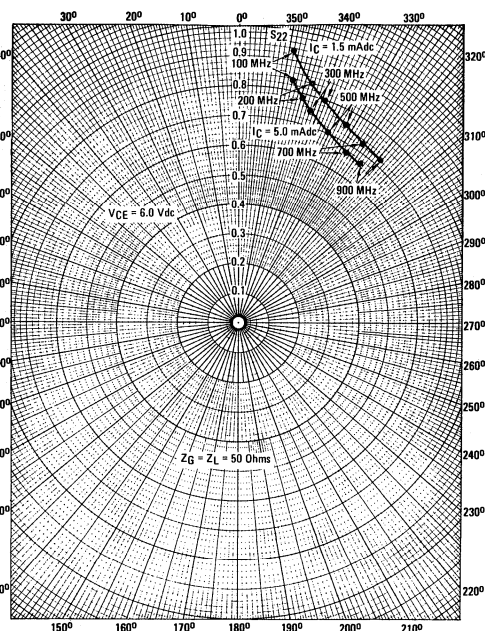
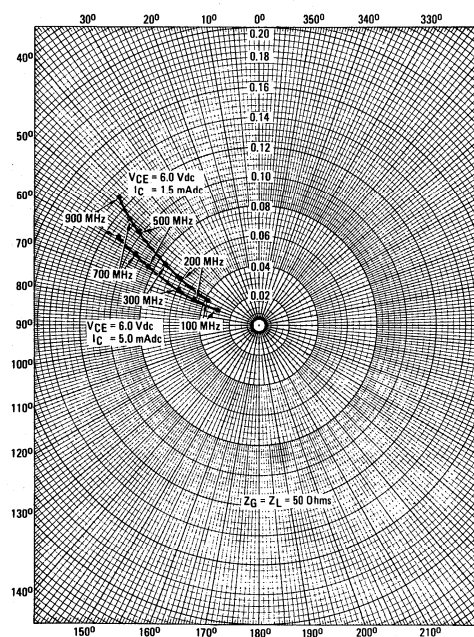
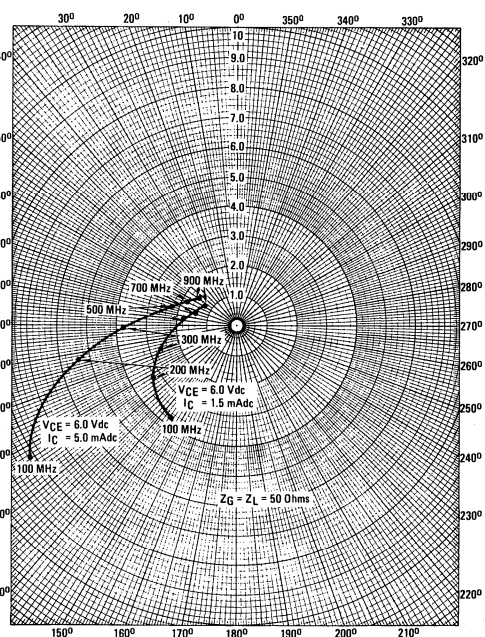
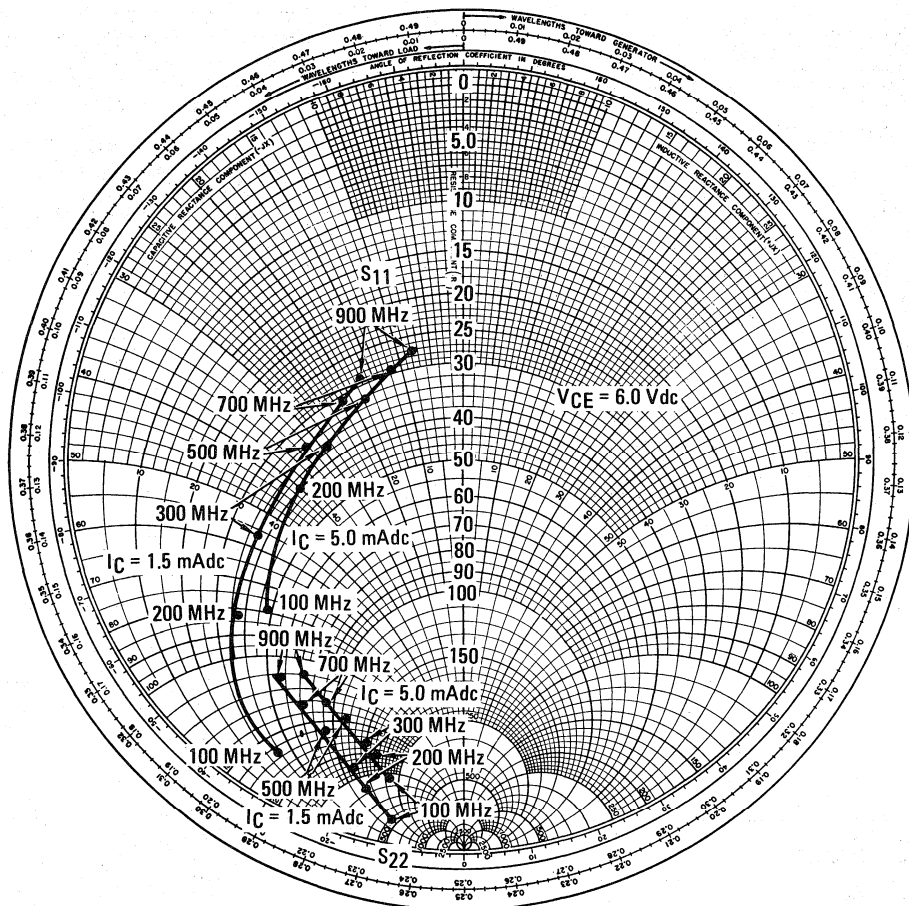
FIGURE 11— S_{11} , INPUT REFLECTION COEFFICIENTFIGURE 12— S_{22} , OUTPUT REFLECTION COEFFICIENTFIGURE 13— S_{12} , REVERSE TRANSMISSION COEFFICIENTFIGURE 14— S_{21} , FORWARD TRANSMISSION COEFFICIENT

FIGURE 15— S_{11} , INPUT REFLECTION COEFFICIENT AND S_{22} , OUTPUT REFLECTION COEFFICIENT

The RF Line

PNP SILICON HIGH-FREQUENCY TRANSISTOR

... designed for applications in high frequency amplifiers and non-saturated switching circuits. High gain-bandwidth product characteristic provides excellent performance in a variety of small signal and linear amplifier applications.

- High Current-Gain-Bandwidth Product —
 $f_T = 1300$ (Min) @ $I_C = 100$ mAdc
- Low Collector-Base Time Constant —
 $\tau_{b' C_C} = 8.0$ ps (Typ) @ $I_C = 50$ mAdc

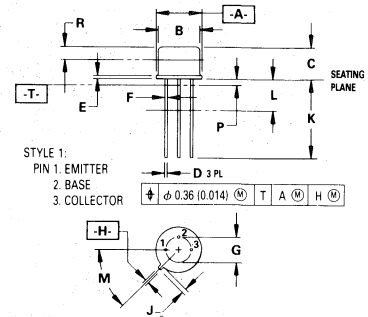
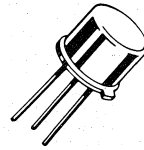
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
* Collector-Emitter Voltage	V_{CEO}	30	Vdc
* Collector-Base Voltage	V_{CB}	30	Vdc
* Emitter-Base Voltage	V_{EB}	3.0	Vdc
* Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1.0 5.71	Watt mW/ $^\circ\text{C}$
* Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	5.0 28.6	Watts mW/ $^\circ\text{C}$
* Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

* Indicates JEDEC Registered Data.

2N5583

1.3 GHz @ 100 mAdc
HIGH-FREQUENCY
TRANSISTOR
PNP SILICON



CASE 79-04
TO-205AD
(TO-39)

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Figure No.	Symbol	Min	Typ	Max	Unit
*OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (Note 1) ($I_C = 10\text{ mAdc}$, $I_B = 0$)	—	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ }\mu\text{Adc}$, $I_E = 0$)	—	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{Adc}$, $I_C = 0$)	—	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 20\text{ Vdc}$, $I_E = 0$)	4	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current ($V_{EB} = 2.0\text{ Vdc}$, $I_C = 0$)	—	I_{EBO}	—	—	0.5	μAdc

***ON CHARACTERISTICS**

DC Current Gain (Note 1) ($I_C = 40\text{ mAdc}$, $V_{CE} = 2.0\text{ Vdc}$) ($I_C = 100\text{ mAdc}$, $V_{CE} = 2.0\text{ Vdc}$) ($I_C = 300\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	1	h_{FE}	20 25 15	40 40 22	— 100 —	—
Collector-Emitter Saturation Voltage (Note 1) ($I_C = 100\text{ mAdc}$, $I_B = 10\text{ mAdc}$)	2,3	$V_{CE(sat)}$	—	0.6	0.8	Vdc
Base-Emitter On Voltage (Note 1) ($I_C = 100\text{ mAdc}$, $V_{CE} = 2.0\text{ Vdc}$)	3	$V_{BE(on)}$	—	0.84	1.8	Vdc

SMALL-SIGNAL CHARACTERISTICS

*Current-Gain-Bandwidth Product ($I_C = 40\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 100\text{ MHz}$) ($I_C = 100\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 100\text{ MHz}$)	7	f_T	1000 1300	1300 1500	— —	MHz
*Collector-Base Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 100\text{ kHz}$)	5	C_{cb}	—	2.5	5.0	pF
*Emitter-Base Capacitance ($V_{EB} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 100\text{ kHz}$)	5	C_{eb}	—	18	35	pF
Collector-Base Time Constant ($I_C = 50\text{ mAdc}$, $V_{CB} = 10\text{ Vdc}$, $f = 63.6\text{ MHz}$)	8	$r_b'C_c$	—	8.0	—	ps

SWITCHING CHARACTERISTICS

Delay Time	$(V_{CC} = 31.4\text{ Vdc}$, $I_C = 150\text{ mAdc}$, $R_C = 160\text{ Ohms}$, $R_E = 26.6\text{ Ohms}$)	9,10	t_d	—	1.0	—	ns
Rise Time		9,10	t_r	—	2.1	—	ns
Fall Time		9,10	t_f	—	1.8	—	ns

*Indicates JEDEC Registered Data.

Note 1: Pulse Test: Pulse Width $\leq 300\text{ }\mu\text{s}$, Duty Cycle = 2.0%.

FIGURE 1 — DC CURRENT GAIN

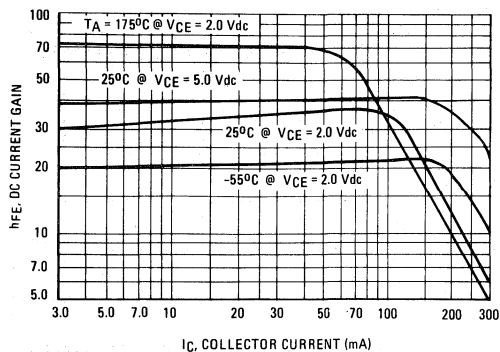


FIGURE 2 — COLLECTOR SATURATION REGION

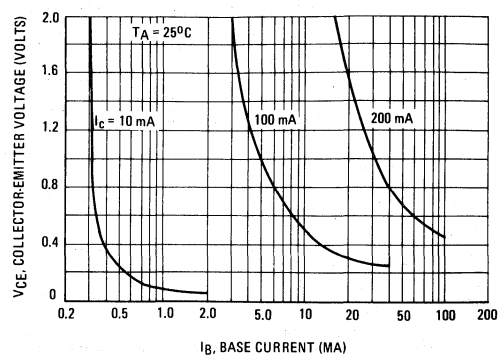


FIGURE 3 — "ON" VOLTAGES

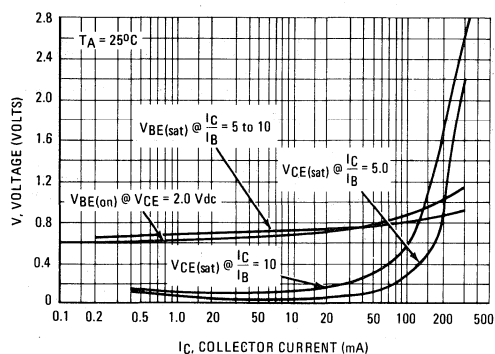


FIGURE 4 — COLLECTOR CURRENT versus BASE VOLTAGE

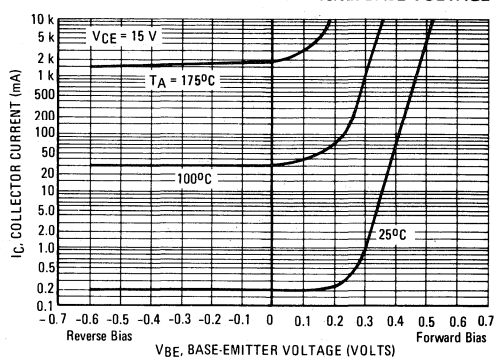


FIGURE 5 — CAPACITANCES

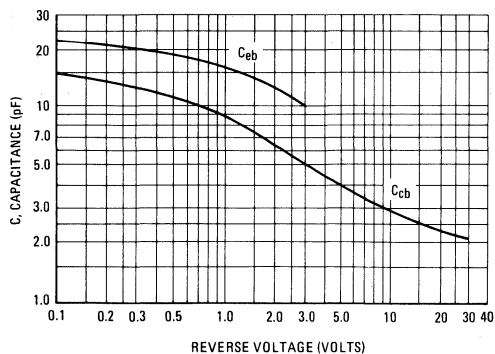


FIGURE 6 — TEMPERATURE COEFFICIENTS

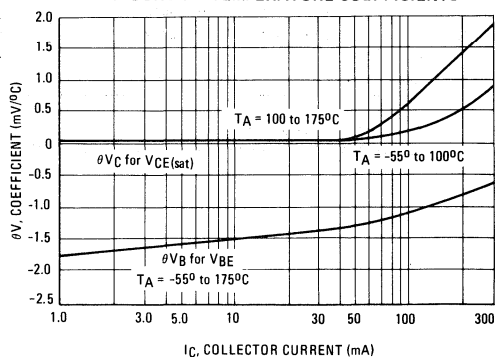


FIGURE 7 – CURRENT-GAIN-BANDWIDTH PRODUCT

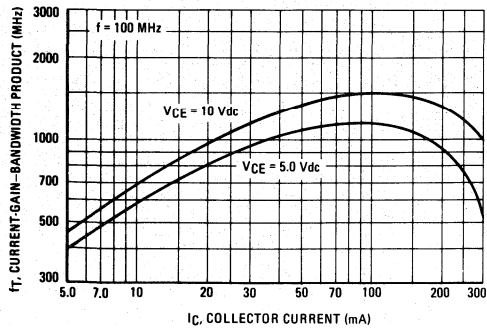


FIGURE 8 – COLLECTOR-BASE TIME CONSTANT

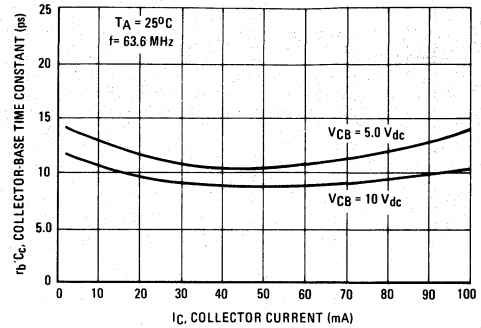


FIGURE 9 – SWITCHING TIMES

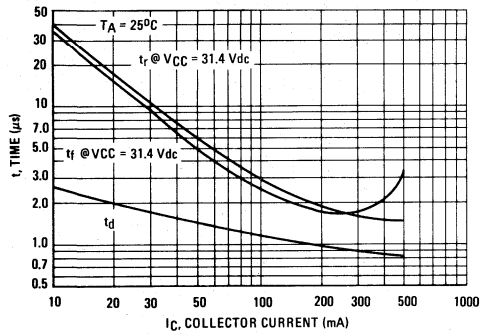
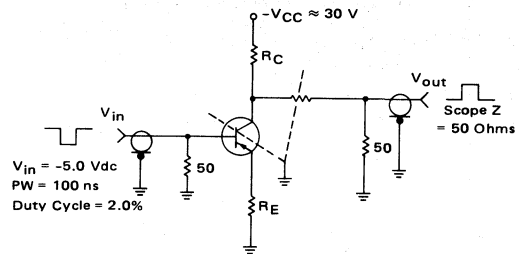


FIGURE 10 – SWITCHING TIMES TEST CIRCUIT



I_C mA	R_C Ohms	R_E Ohms	V_{CC} Volts
50	526	80	34.4
150	160	26.6	31.4
300	78	13.3	30.6
500	46.5	8.0	30.3

2N5641

The RF Line

NPN SILICON RF POWER TRANSISTOR

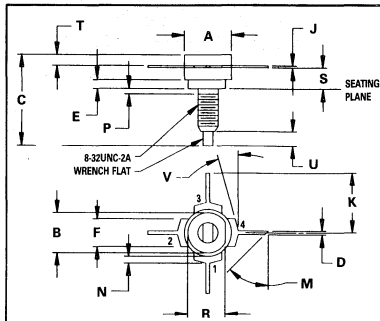
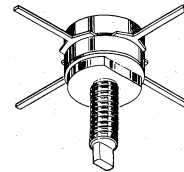
... designed primarily for wideband large-signal amplifier stages in the 125-175 MHz frequency range.

- Specified 28 Volt, 175 MHz Characteristics —
Output Power = 7.0 Watts
Minimum Gain = 8.4 dB
Efficiency = 60%
- Characterized from 125 to 175 MHz
- Includes Series Equivalent Impedances

7.0 W — 175 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	0.64	0.89	0.025	0.035
E	1.78	—	0.070	—
F	5.46	5.97	0.215	0.235
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
M	45° NOM		45° NOM	
N	1.27	1.52	0.050	0.060
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132
V	10°	20°	10°	20°

CASE 144B-05

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	65	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	15 86	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

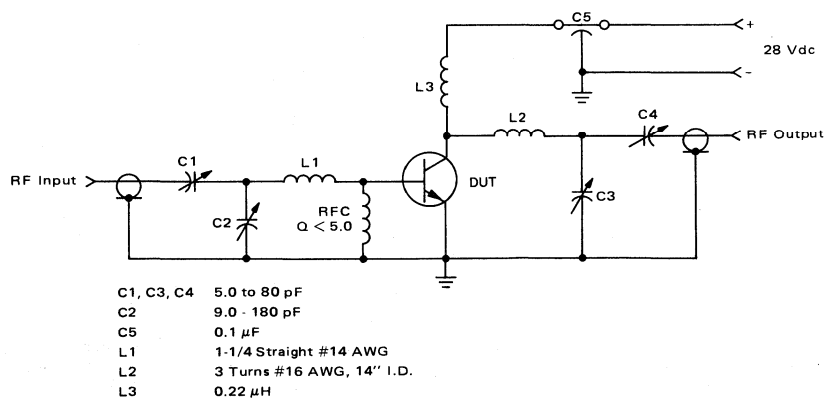
***ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (Note 1) ($I_C = 200\text{ mA dc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA dc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA dc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA dc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA dc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 0.1$ to 1.0 MHz)	C_{ob}	—	8.5	15	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 1) ($P_{out} = 7.0\text{ Watts}$, $V_{CE} = 28\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{pE}	8.4	12.5	—	dB
Collector Efficiency (Figure 1) ($P_{out} = 7.0\text{ Watts}$, $V_{CE} = 28\text{ Vdc}$, $f = 175\text{ MHz}$)	η	60	—	—	%

Note 1: Pulsed through 25 mH inductor.

*Indicates JEDEC Registered Data.

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC



2

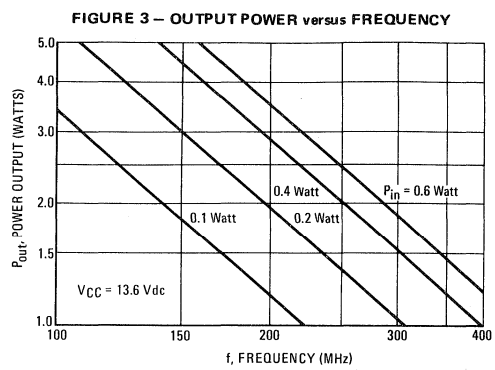
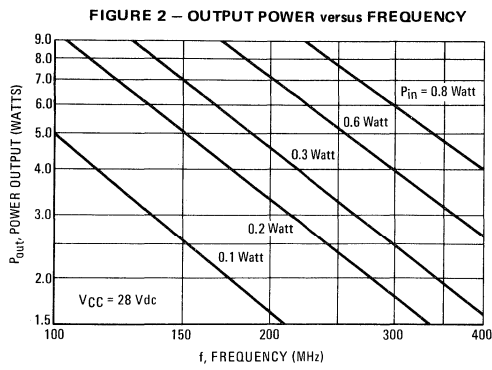
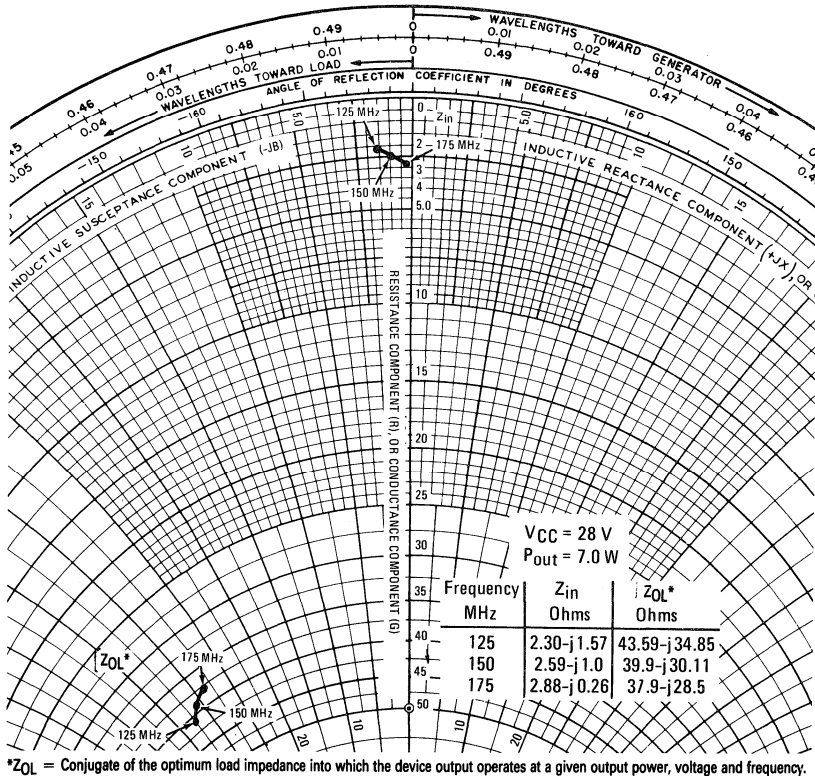


FIGURE 4 – SERIES EQUIVALENT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2N5642

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for wideband large-signal amplifier stages in the 125-175 MHz frequency range.

- Specified 28 Volt, 175 MHz Characteristics —
Output Power = 20 Watts
Minimum Gain = 8.2 dB
Efficiency = 60%
- Characterized from 125 to 175 MHz
- Includes Series Equivalent Impedances

***MAXIMUM RATINGS**

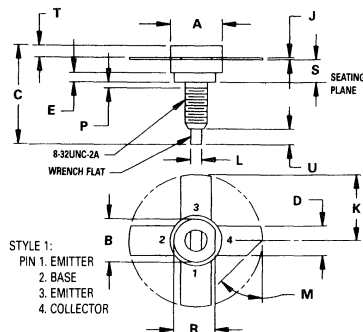
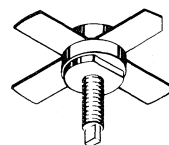
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	65	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous	I_C	3.0	A _{dc}
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	30 171	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

20 W — 175 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45°	NOM	45°	NOM
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (Note 1) ($I_C = 200\text{ mA dc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA dc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA dc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA dc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 200\text{ mA dc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 0.1$ to 1.0 MHz)	C_{ob}	—	22	35	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 1) ($P_{out} = 20\text{ Watts}$, $V_{CE} = 28\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{PE}	8.2	10.2	—	dB
Collector Efficiency (Figure 1) ($P_{out} = 20\text{ Watts}$, $V_{CE} = 28\text{ Vdc}$, $f = 175\text{ MHz}$)	η	60	—	—	%

Note 1: Pulsed through 25 mH inductor.

*Indicates JEDEC Registered Data.

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC

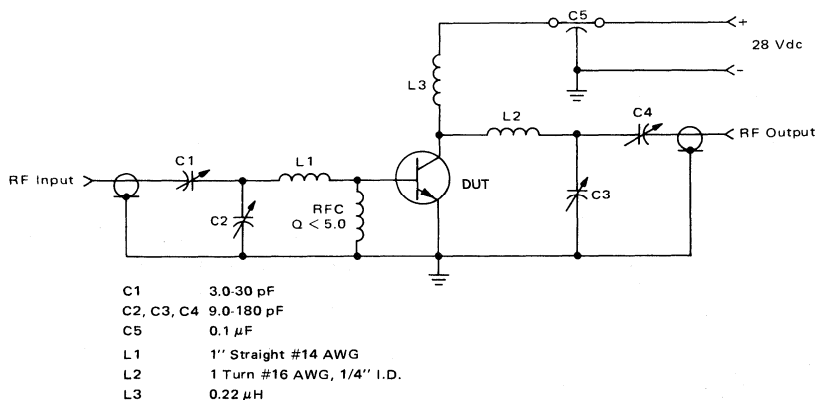


FIGURE 2 — OUTPUT POWER versus FREQUENCY

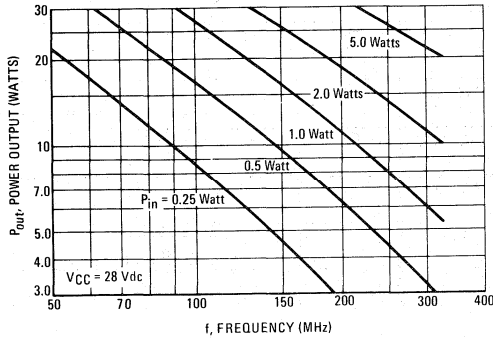


FIGURE 3 — OUTPUT POWER versus FREQUENCY

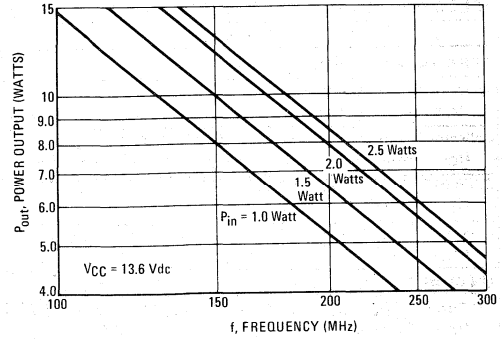
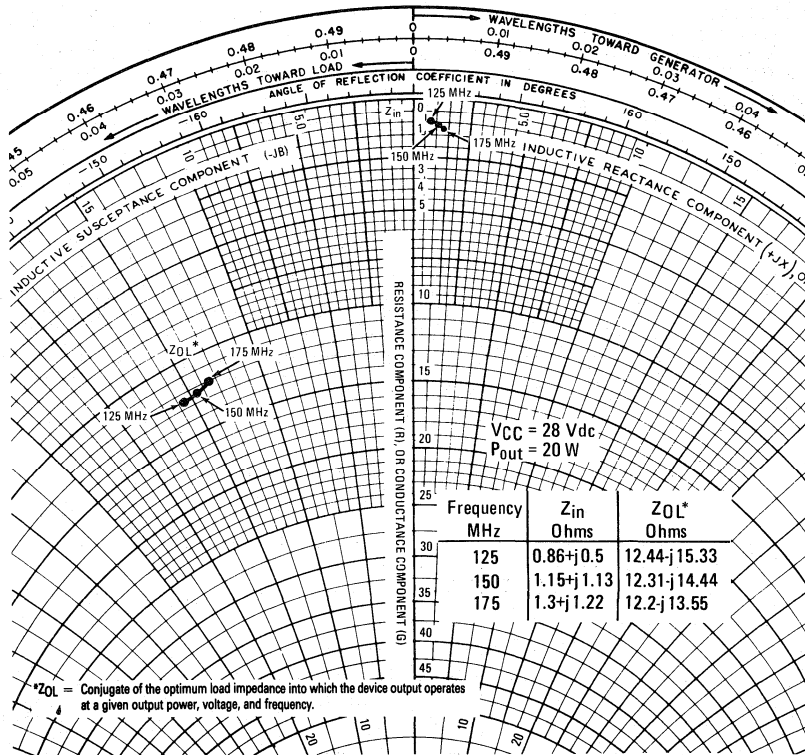


FIGURE 4 — SERIES EQUIVALENT IMPEDANCE



2N5643

The RF Line

NPN SILICON RF POWER TRANSISTOR

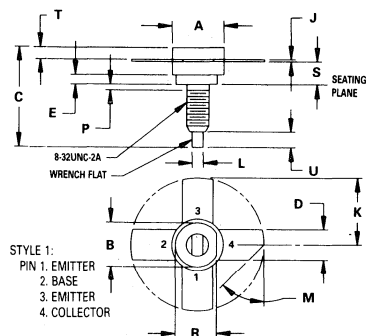
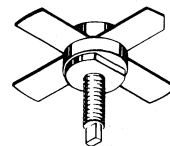
... designed primarily for wideband large-signal amplifier stages in the 125-175 MHz frequency range.

- Specified 28 Volt, 175 MHz Characteristics —
Output Power = 40 Watts
Minimum Gain = 7.6 dB
Efficiency = 60%
- Characterized from 125 to 175 MHz
- Includes Series Equivalent Impedances

40 W — 175 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	65	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	60 342	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (Note 1) ($I_C = 200\text{ mA dc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA dc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA dc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA dc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 500\text{ mA dc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 0.1$ to 1.0 MHz)	C_{ob}	—	45	65	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 1) ($P_{out} = 40\text{ Watts}$, $V_{CE} = 28\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{pE}	7.6	8.1	—	dB
Collector Efficiency (Figure 1) ($P_{out} = 40\text{ Watts}$, $V_{CE} = 28\text{ Vdc}$, $f = 175\text{ MHz}$)	η	60	—	—	%

Note 1: Pulsed through 25 mH inductor.

*Indicates JEDEC Registered Data.

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC

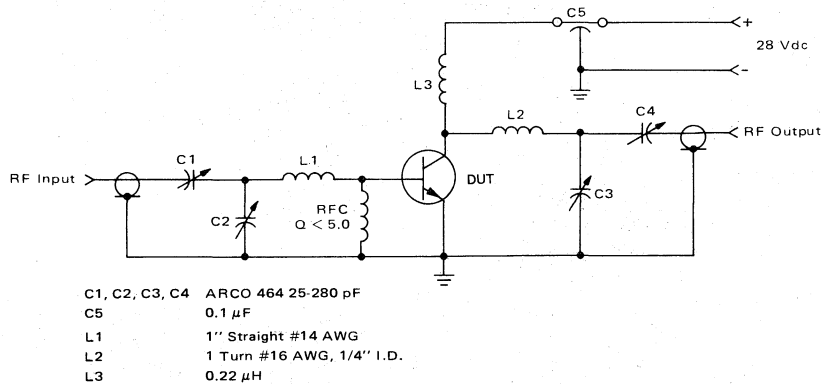


FIGURE 2 – OUTPUT POWER versus FREQUENCY

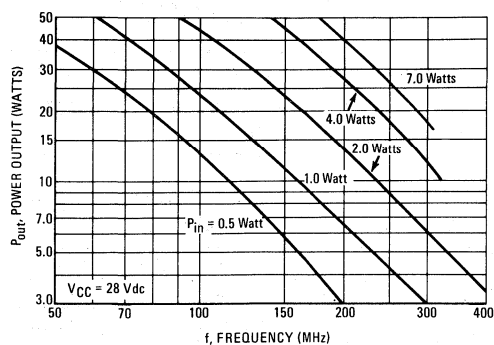


FIGURE 3 – OUTPUT POWER versus FREQUENCY

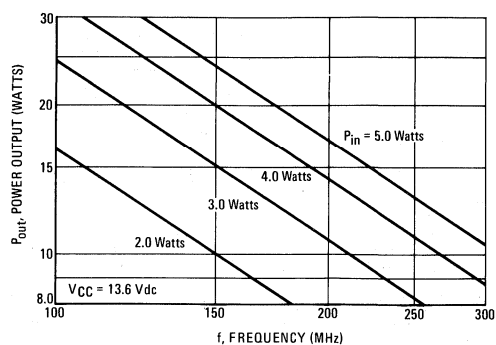
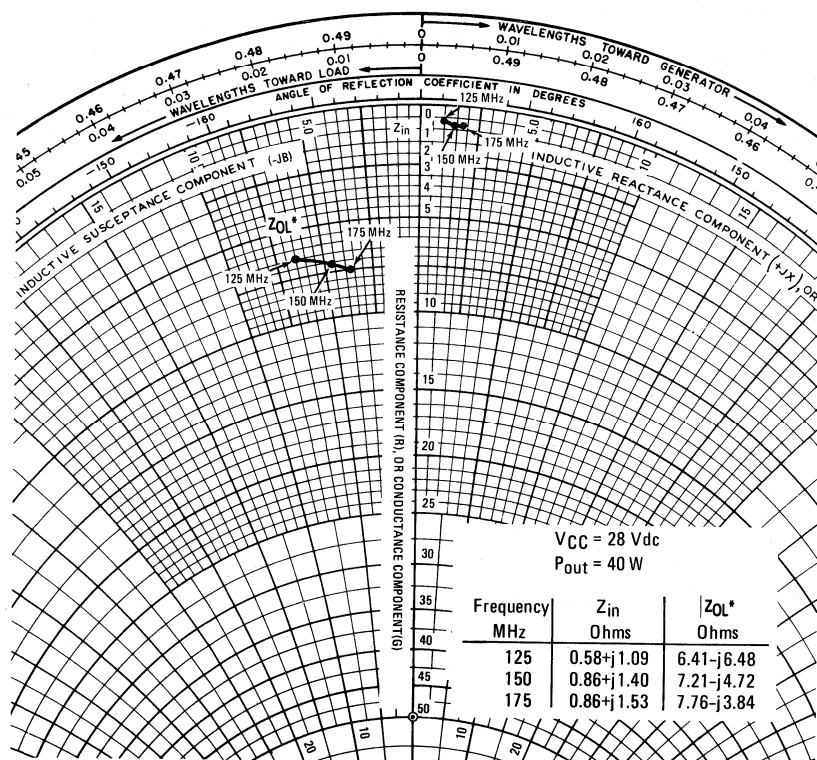


FIGURE 4 – SERIES EQUIVALENT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

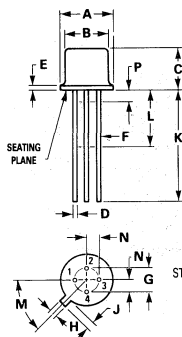
... designed primarily for use in fact current-mode switching circuits in military and industrial equipment. Suitable for use in general high-frequency amplifier applications to 1.5 GHz.

- 2N5835 — 10 mAdc, 6.0 Vdc Characteristics
 $f_T = 2.5 \text{ GHz (Min)}$
 $r_b'C_c = 5.0 \text{ ps (Typ)}$
 $t_r = 250 \text{ ps (Typ)}$
- 2N5836 — 50 mAdc, 6.0 Vdc Characteristics —
 $f_T = 2.0 \text{ GHz (Min)}$
 $r_b'C_c = 6.0 \text{ ps (Typ)}$
 $t_r = 320 \text{ ps (Typ)}$
- 2N5837 — 100 mAdc, 3.0 Vdc Characteristics —
 $f_T = 1.7 \text{ GHz (Min)}$
 $r_b'C_c = 6.0 \text{ ps (Typ)}$
 $t_r = 650 \text{ ps (Typ)}$

*MAXIMUM RATINGS

Rating	Symbol	2N5835	2N5836	2N5837	Unit
Collector-Emitter Voltage	V_{CE0}	10	10	5.0	Vdc
Collector-Base Voltage	V_{CBO}	15	15	10	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	3.5	3.5	Vdc
Collector Current — Continuous	I_C	15	200	300	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	200	300	300	mW mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 100^\circ\text{C}$ Derate above 100°C	P_D	—	0.75 7.5	0.75 7.5	Watts mW/ $^\circ\text{C}$
Storage Junction Temperature Range	T_{stg}	—65 to +200			$^\circ\text{C}$

* Indicates JEDEC Registered Data.



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

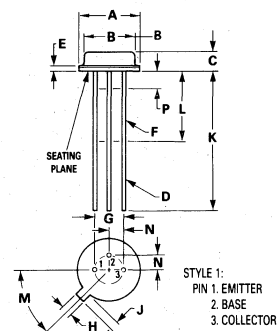
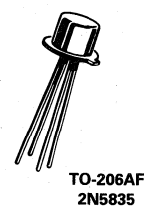
CASE 20-03
TO-206AF
(TO-72)

2N5835
2N5836
2N5837

2.5 GHz @ 10 mAdc — 2N5835
2.0 GHz @ 50 mAdc — 2N5836
1.7 GHz @ 100 mAdc — 2N5837

HIGH FREQUENCY TRANSISTORS

NPN SILICON



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	1.65	2.16	0.065	0.085
D	0.406	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.305	0.483	0.012	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 26-03
TO-206AB
(TO-46)

*ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Breakdown Voltage ($I_C = 10\text{ }\mu\text{Adc}$, $I_E = 0$) <div>2N5835</div> <div>($I_C = 100\text{ }\mu\text{Adc}$, $I_E = 0$)<div>2N5836</div><div>2N5837</div></div>		$V_{(BR)CBO}$	15 15 10	— — —	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{Adc}$, $I_C = 0$)		$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 7.5\text{ Vdc}$, $I_E = 0$) <div>2N5835</div> <div>($V_{CB} = 10\text{ Vdc}$, $I_E = 0$)<div>2N5836</div><div>($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$)<div>2N5837</div></div></div>		I_{CBO}	— — —	— — —	0.01 10 10	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0\text{ Vdc}$, $I_C = 0$)		I_{EBO}	—	—	100	μAdc
ON CHARACTERISTICS						
DC Current Gain ($I_C = 10\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$) <div>2N5835</div> <div>($I_C = 50\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$)<div>2N5836</div><div>($I_C = 100\text{ mAdc}$, $V_{CE} = 3.0\text{ Vdc}$)<div>2N5837</div></div></div>		h_{FE}	25 25 25	— — —	— — —	—
Base-Emitter On Voltage ($I_C = 10\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$) <div>2N5835</div> <div>($I_C = 50\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$)<div>2N5836</div><div>($I_C = 100\text{ mAdc}$, $V_{CE} = 3.0\text{ Vdc}$)<div>2N5837</div></div></div>		$V_{BE(on)}$	— — —	— — —	0.9 0.9 0.9	Vdc
DYNAMIC CHARACTERISTICS						
Current-Gain—Bandwidth Product ① ($I_C = 10\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 200\text{ MHz}$) <div>2N5835</div> <div>($I_C = 50\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 200\text{ MHz}$)<div>2N5836</div><div>($I_C = 100\text{ mAdc}$, $V_{CE} = 3.0\text{ Vdc}$, $f = 200\text{ MHz}$)<div>2N5837</div></div></div>		f_T	2.5 2.0 1.7	— — —	— — —	GHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ to }1.0\text{ MHz}$) <div>2N5835</div> <div>2N5836</div> <div>($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ to }1.0\text{ MHz}$)<div>2N5837</div></div>		C_{cb}	— — —	— — —	0.8 3.5 5.0	pF
Collector-Base Time Constant ② ($I_C = 10\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 63.6\text{ MHz}$) <div>2N5835</div> <div>($I_C = 50\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 63.6\text{ MHz}$)<div>2N5836</div><div>($I_C = 100\text{ mAdc}$, $V_{CE} = 3.0\text{ Vdc}$, $f = 63.6\text{ MHz}$)<div>2N5837</div></div></div>		$\tau_b C_C$	— — —	5.0 6.0 6.0	— — —	ps
SWITCHING CHARACTERISTICS ②						
Rise Time (See Figure 1) <div>($I_C = 10\text{ mAdc}$)<div>2N5835</div><div>($I_C = 40\text{ mAdc}$)<div>2N5836</div><div>($I_C = 100\text{ mAdc}$)<div>2N5837</div></div></div></div>		t_r	— — —	250 320 650	— — —	ps

* Indicates JEDEC Registered Data

① f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

② Typical values shown in addition to JEDEC Registered Data.

FIGURE 1 — SWITCHING TIME TEST CIRCUIT

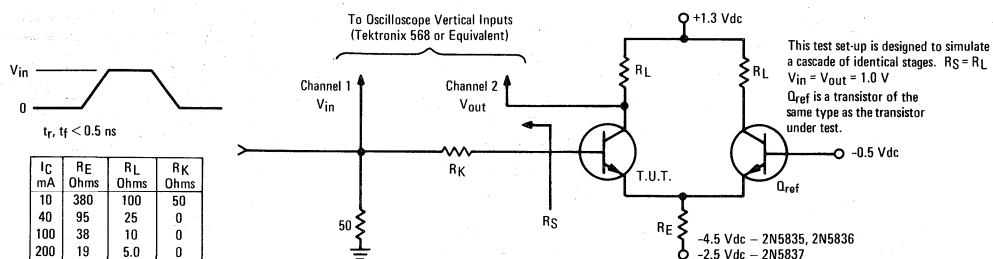


FIGURE 2 – SWITCHING TIME

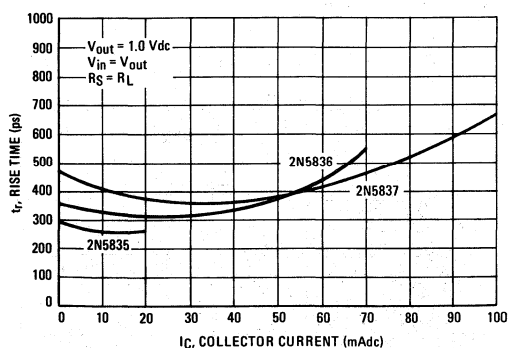


FIGURE 3 – CURRENT-GAIN-BANDWIDTH PRODUCT

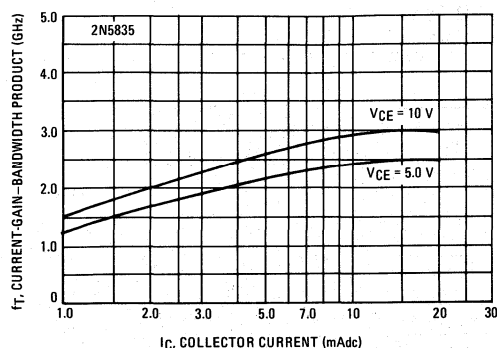


FIGURE 4 – CURRENT-GAIN-BANDWIDTH PRODUCT

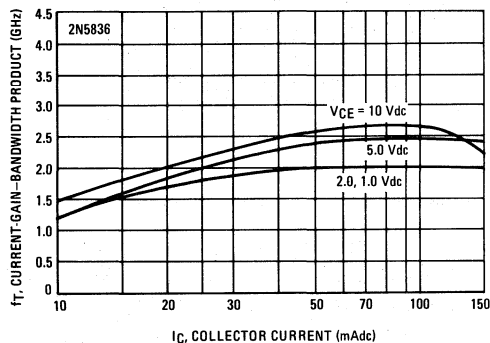


FIGURE 5 – CURRENT-GAIN-BANDWIDTH PRODUCT

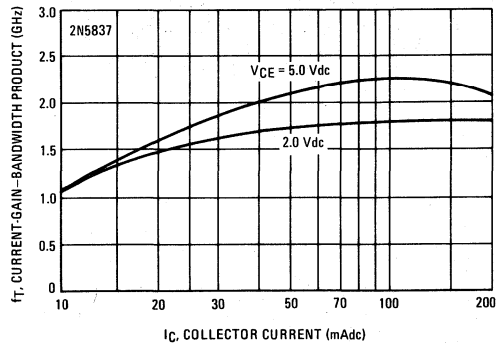


FIGURE 6 – COLLECTOR-BASE TIME CONSTANT

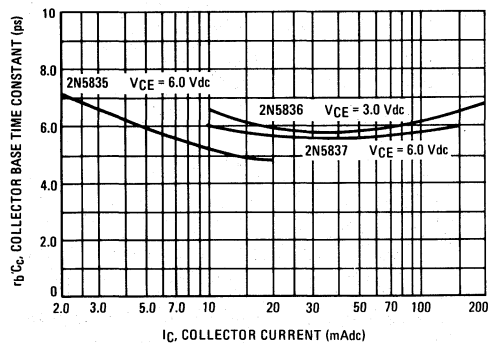
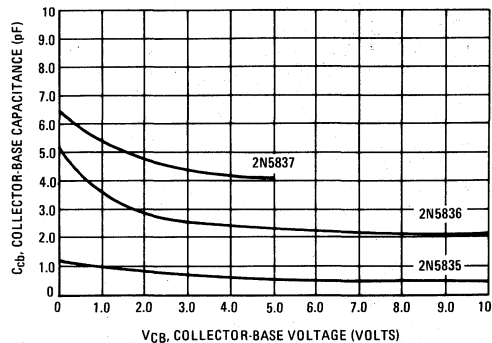
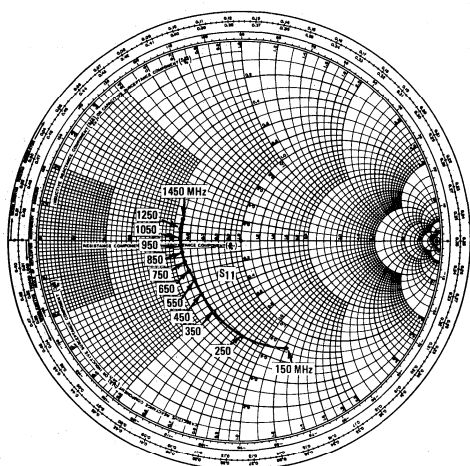
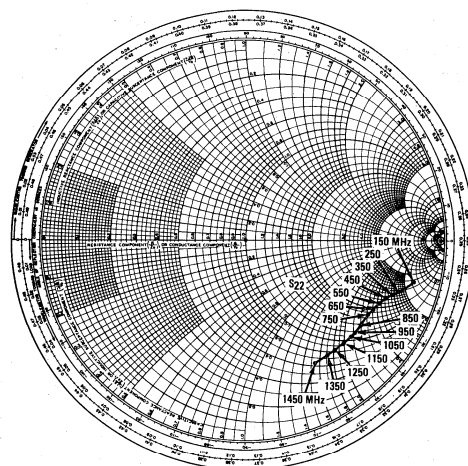
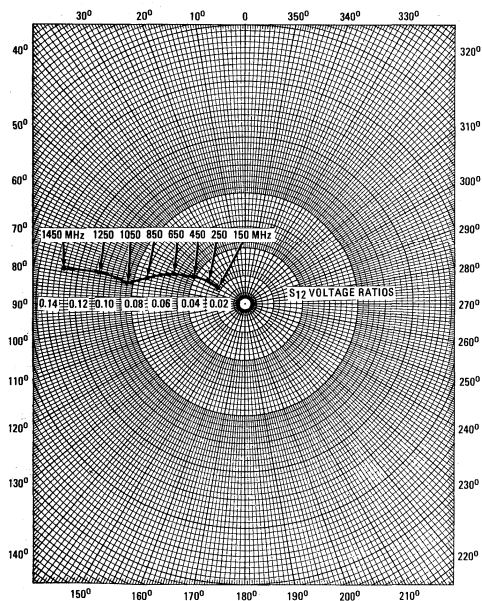
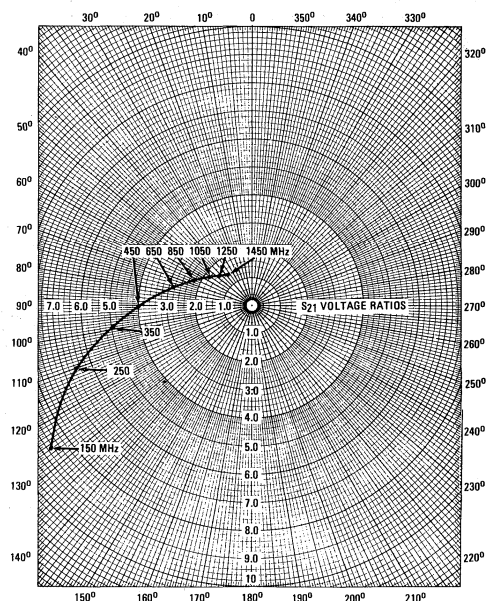


FIGURE 7 – COLLECTOR-BASE CAPACITANCE



2N5835 SCATTERING PARAMETERS
 $(I_C = 5.0 \text{ mA dc}, V_{CE} = 6.0 \text{ V dc}, Z_G = Z_L = 50 \text{ Ohms})$

FIGURE 8 – S_{11} , INPUT REFLECTION COEFFICIENTFIGURE 9 – S_{22} , OUTPUT REFLECTION COEFFICIENTFIGURE 10 – S_{12} , REVERSE TRANSMISSION COEFFICIENTFIGURE 11 – S_{21} , FORWARD TRANSMISSION COEFFICIENT

2N5836 SCATTERING PARAMETERS
 $(I_C = 100 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, Z_G = Z_L = 50 \text{ Ohms})$

FIGURE 12 — S_{11} , INPUT REFLECTION COEFFICIENT

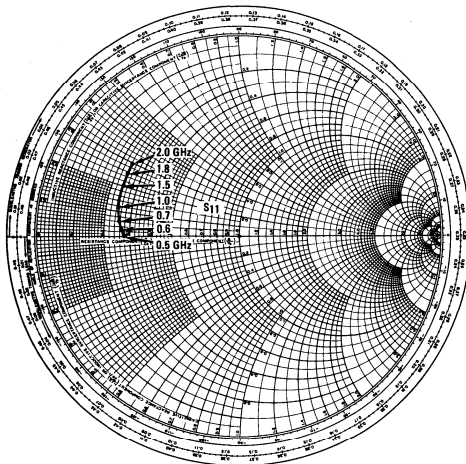


FIGURE 13 — S_{22} , OUTPUT REFLECTION COEFFICIENT

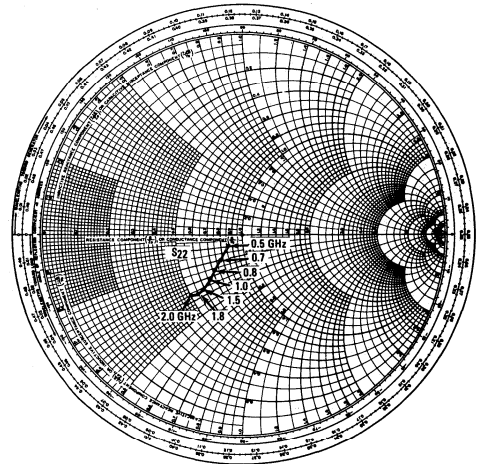


FIGURE 14 — S_{12} , REVERSE TRANSMISSION COEFFICIENT

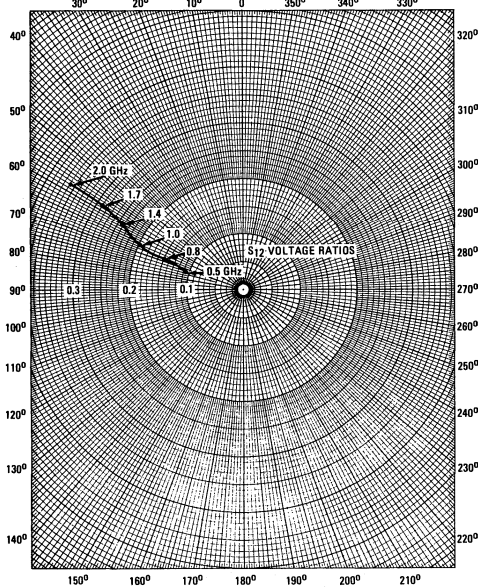
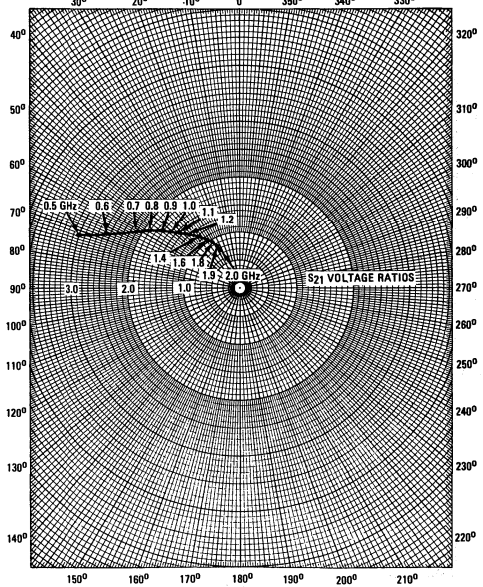


FIGURE 15 — S_{21} , FORWARD TRANSMISSION COEFFICIENT



2N5837 SCATTERING PARAMETERS
 $(I_C = 100 \text{ mAdc}, V_{CE} = 3.0 \text{ Vdc}, Z_G = Z_L = 50 \text{ Ohms})$

FIGURE 16 – S_{11} , INPUT REFLECTION COEFFICIENT

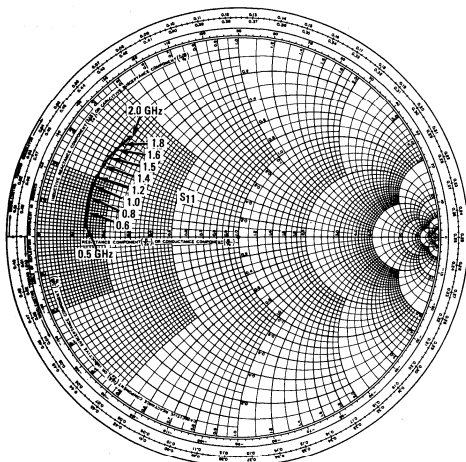


FIGURE 17 – S_{22} , OUTPUT REFLECTION COEFFICIENT

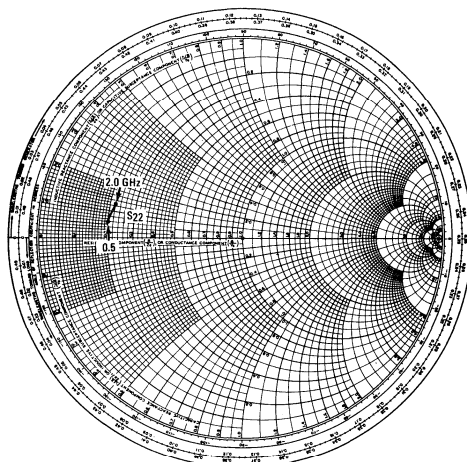


FIGURE 18 – S_{12} , REVERSE TRANSMISSION COEFFICIENT

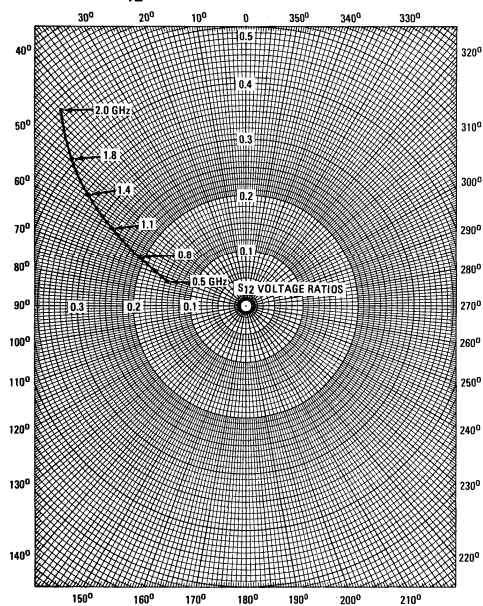
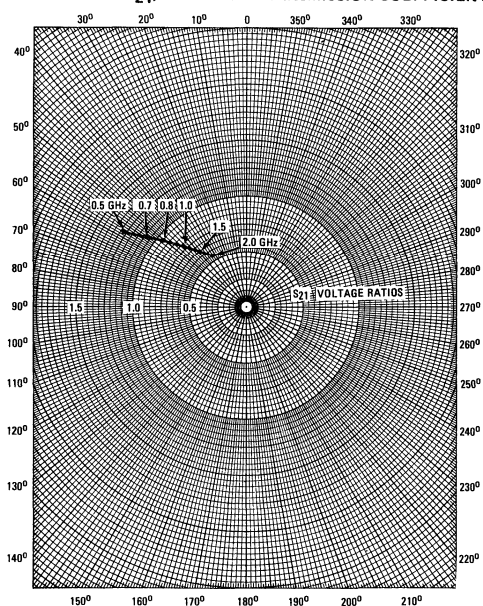


FIGURE 19 – S_{21} , FORWARD TRANSMISSION COEFFICIENT



2N5849

2

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for use in large-signal amplifier output stages, the 2N5849 is intended for use in industrial communications equipment operating at frequencies to 80 MHz.

- Specified 12.5 Volt, 50 MHz Characteristics —
Output Power = 40 Watts
Minimum Gain = 7.5 dB
Efficiency = 50%

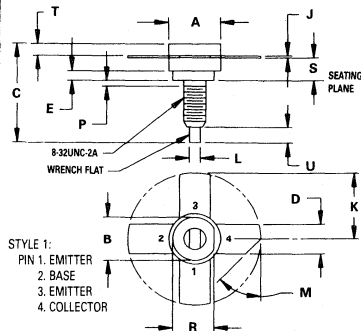
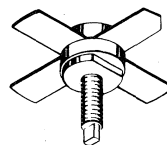
***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CB}	48	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous	I_C	7.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	100 571	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

40 W-50 MHz
RF POWER
TRANSISTOR
NPN SILICON



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 200 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Emitter Breakdown Voltage(1) ($I_C = 100 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	48	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $V_{BE} = 0$, $T_A = +125^\circ\text{C}$)	I_{CES}	—	—	10	mAdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 2.4 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	3.0	—	—	—
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DYNAMIC CHARACTERISTICS

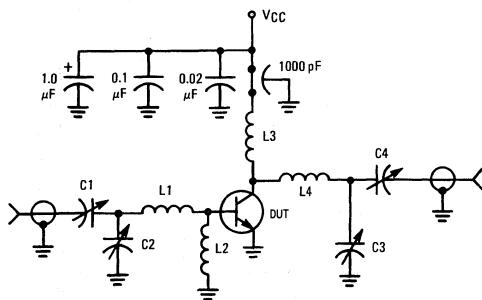
Output Capacitance ($V_{CB} = 12.5 \text{ Vdc}$, $I_E = 0$, $f = 0.1$ to 1.0 MHz)	C_{ob}	—	180	230	pF
--	----------	---	-----	-----	----

FUNCTIONAL TEST

Common-Emitter Amplifier Power Gain ($P_{out} = 40 \text{ W}$, $V_{CC} = 12.5 \text{ Vdc}$, $f = 50 \text{ MHz}$)	G_{pE}	7.5	—	—	dB
Collector Efficiency ($P_{out} = 40 \text{ W}$, $V_{CC} = 12.5 \text{ Vdc}$, $f = 50 \text{ MHz}$)	η	50	—	—	%

*Indicates JEDEC Registered Data.
(1) Pulsed thru a 25 mH Inductor.

FIGURE 1 — 50 MHz POWER GAIN TEST CIRCUIT



- C1 25-280 pF, Arco 464 or Equivalent
- C2 80-480 pF, Arco 466 or Equivalent
- C3 0.75 pF, Hammarlund MAPC 75 or Equivalent
- C4 0.50 pF, Hammarlund MAPC 50 or Equivalent
- L1 1 Turn #14 AWG 5/16" I.D.
- L2 2-1/2 Turns #22 AWG on 3/8" Ferrite Bead
- L3 18 Turns #18 AWG 3/8" I.D. 2 Layers, 9 Turns Each
- L4 4 Turns #14 AWG 7/16" I.D. 7/16" Long

FIGURE 2 – POWER OUTPUT versus POWER INPUT

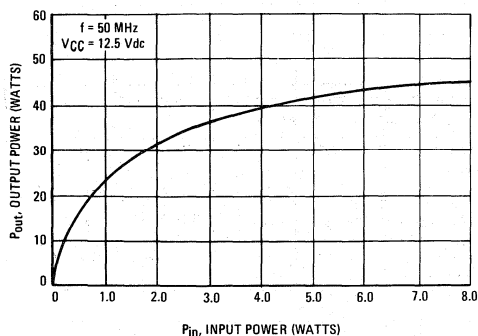


FIGURE 4 – PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

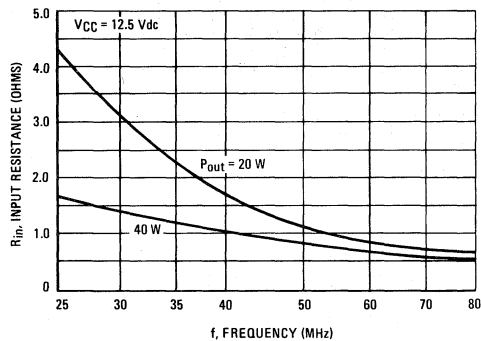


FIGURE 6 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

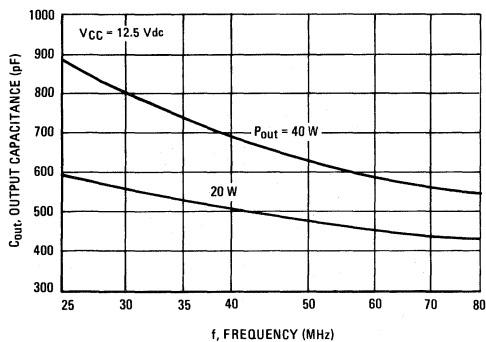


FIGURE 3 – POWER OUTPUT versus FREQUENCY

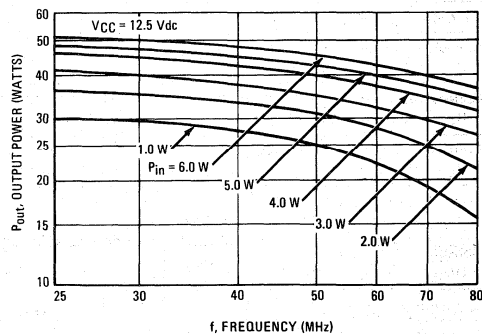


FIGURE 5 – PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

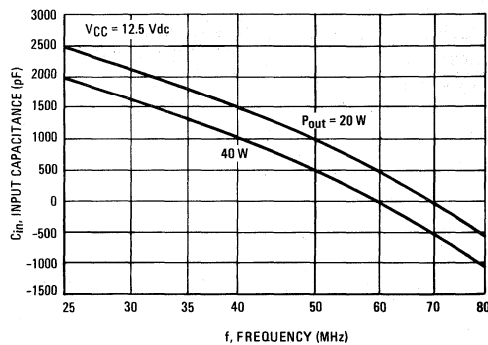
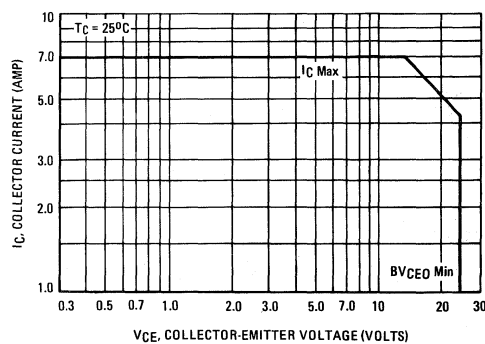
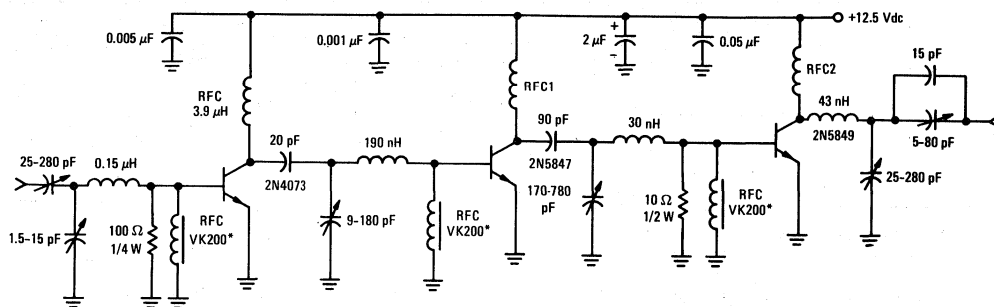


FIGURE 7 – DC SAFE OPERATING AREA



40 WATT, 50 MHz TRANSMITTER SCHEMATIC



$P_O = 40 \text{ W}$
 $P_{in} = 20 \text{ mW}$
 Overall Gain = 33 dB
 Overall Efficiency = 59.2%

*Ferroxcube Part Number
 RFC1 - 20 Turns #18 AWG, 3/16" I.D., 2 Layers,
 10 Turns Each, Close Wound.
 RFC2 - 18 Turns, #18 AWG, 3/16" I.D., 2 Layers,
 9 Turns Each, Close Wound.

2N5943

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

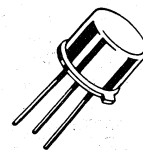
... designed specifically for broadband applications requiring low cross-modulation distortion and low-noise figure. Characterized for use in CATV applications.

- Low Noise Figure — @ $f = 200$ MHz
NF (Narrowband) = 3.4 dB (Typ)
NF (Broadband) = 6.8 dB (Typ)
- High Current-Gain — Bandwidth Product —
 $f_T = 1200$ MHz (Min) @ $I_C = 50$ mAdc
- Completely Characterized with s and y-Parameters

1.2 GHz — 50 mAdc

**NPN SILICON
HIGH-FREQUENCY
TRANSISTOR**

NPN SILICON

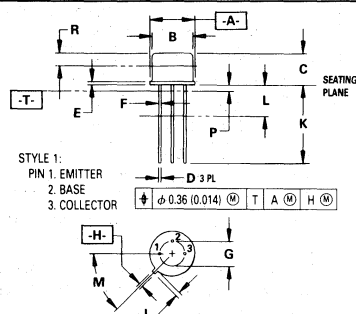
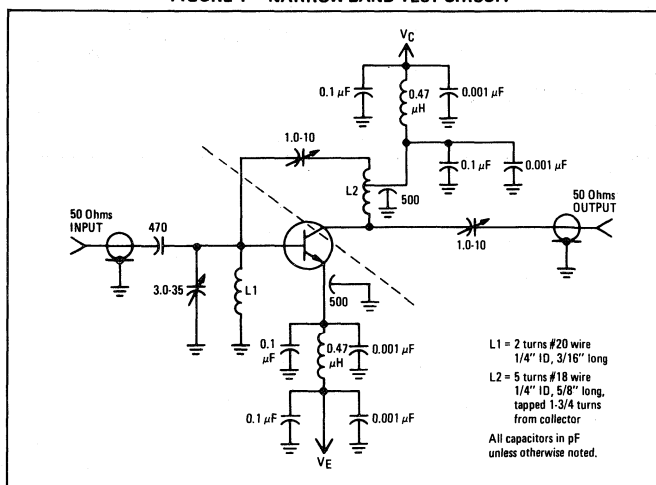


***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1.0 5.7	Watt mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	3.5 0.02	Watts W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

FIGURE 1 — NARROW-BAND TEST CIRCUIT



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-04
TO-205AD
(TO-39)**

*ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{A}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 20\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	50	μA
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$)	h_{FE}	25	—	300	—
Collector-Emitter Saturation Voltage ($I_C = 100\text{ mA}$, $I_B = 10\text{ mA}$)	$V_{CE(sat)}$	—	0.15	0.2	Vdc
Base-Emitter Saturation Voltage ($I_C = 100\text{ mA}$, $I_B = 10\text{ mA}$)	$V_{BE(sat)}$	—	0.88	1.0	Vdc

DYNAMIC CHARACTERISTICS

Current-Gain — Bandwidth Product (Figure 2) ($I_C = 25\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$) ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$) ($I_C = 100\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	1000 1200 1000	1350 1550 1425	— 2400 —	MHz
Collector-Base Capacitance (Figure 5) ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 100\text{ kHz}$)	C_{cb}	1.0	1.6	2.5	pF
Emitter-Base Capacitance (Figure 5) ($V_{EB} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 100\text{ kHz}$)	C_{eb}	—	8.4	15	pF
Small-Signal Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{fe}	25	—	350	—
Collector-Base Time Constant ($I_E = 50\text{ mA}$, $V_{CB} = 15\text{ Vdc}$, $f = 31.8\text{ MHz}$)	$r_b'C_c$	2.0	5.5	20	ps
Noise Figure ($I_C = 30\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$) (Figure 1) ($I_C = 35\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$) (Figures 6, 11, 14) (1)	NF	— —	3.4 6.8	— 8.0	dB

FUNCTIONAL TEST

Common-Emitter Amplifier Power Gain ($I_C = 10\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$) (Figure 1) ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 250\text{ MHz}$) (Figure 6)	G_{pe}	— 7.0	11.4 7.6	— —	dB
Intermodulation Distortion (Figure 7) ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $V_{out} = +50\text{ dBmV}$)	IM	—	—	-50	dB
Cross Modulation Distortion (Figure 8) ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $V_{out} = +40\text{ dBmV}$) ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $V_{out} = +50\text{ dBmV}$)	XM	— —	-67 -45	— -42	dB

*Indicates JEDEC Registered Data.

(1) Includes noise figure of post-amplifier and matching pad.

FIGURE 2 – CURRENT-GAIN – BANDWIDTH PRODUCT

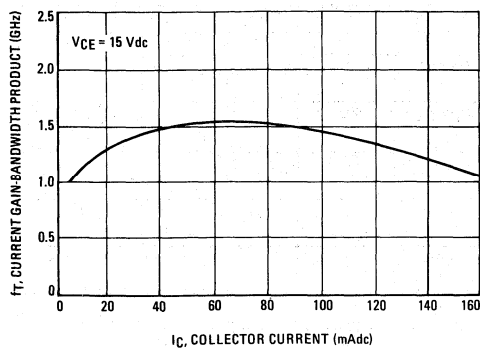


FIGURE 3 – COLLECTOR-BASE TIME CONSTANT

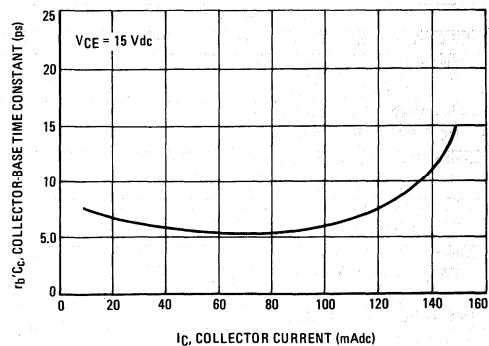


FIGURE 4 – SATURATION VOLTAGES

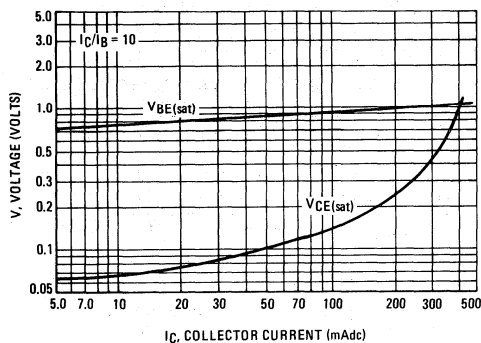


FIGURE 5 – CAPACITANCES versus REVERSE VOLTAGE

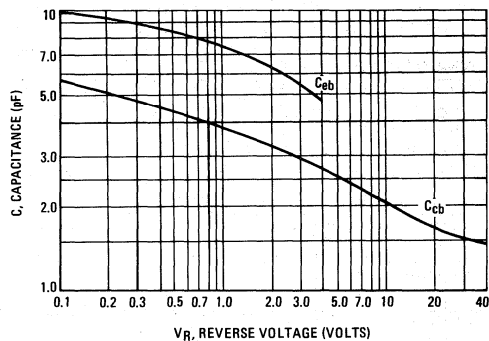


FIGURE 6 – BROADBAND TEST CIRCUIT

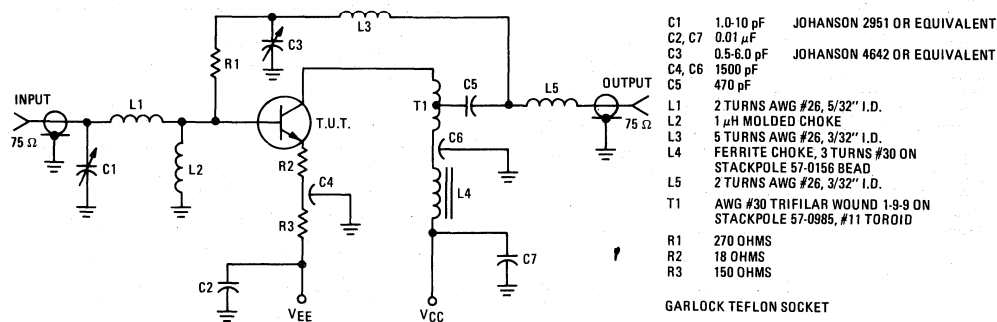


FIGURE 7 – CROSS-MODULATION DISTORTION versus COLLECTOR CURRENT

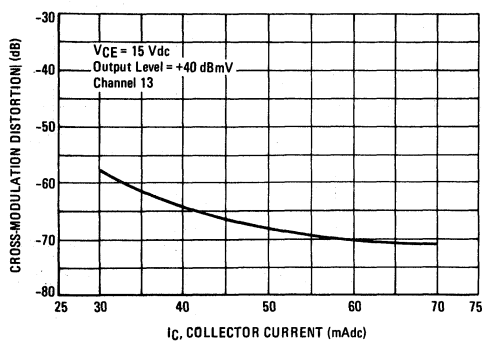


FIGURE 8 – CROSS-MODULATION DISTORTION versus OUTPUT LEVEL

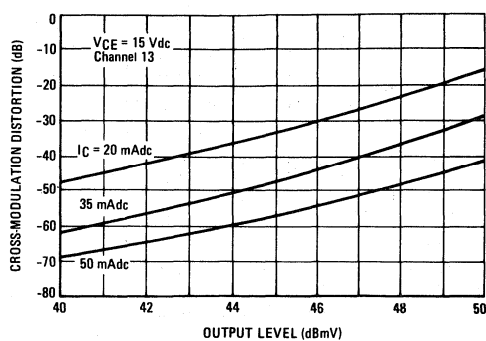


FIGURE 9 – NARROWBAND NOISE FIGURE versus COLLECTOR CURRENT

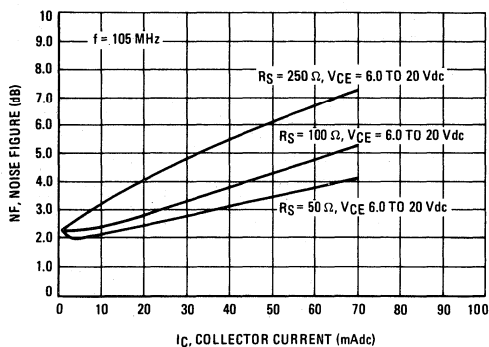


FIGURE 10 – NARROWBAND NOISE FIGURE versus COLLECTOR CURRENT

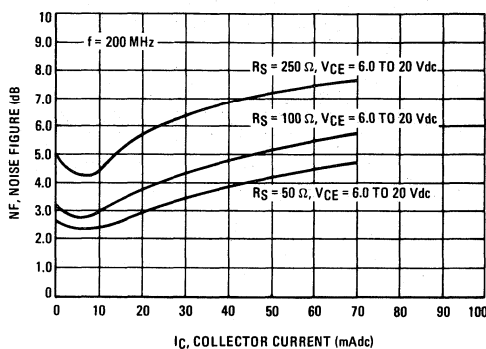


FIGURE 11 – BROADBAND NOISE FIGURE versus COLLECTOR CURRENT

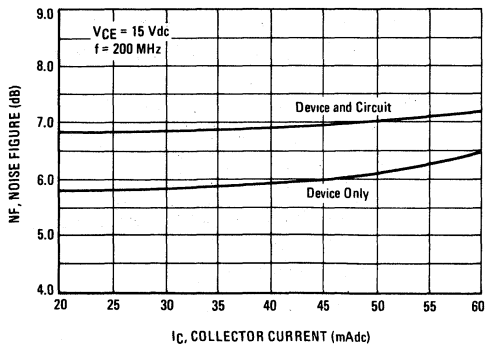


FIGURE 12 – NARROWBAND NOISE FIGURE versus FREQUENCY

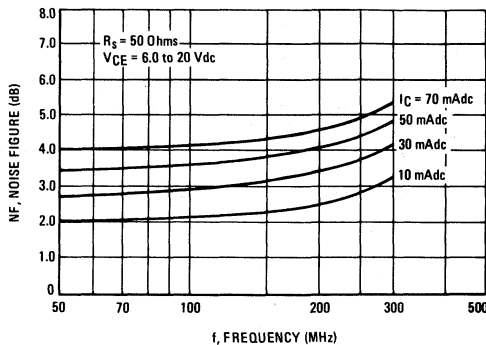


FIGURE 13 — INPUT ADMITTANCE versus FREQUENCY

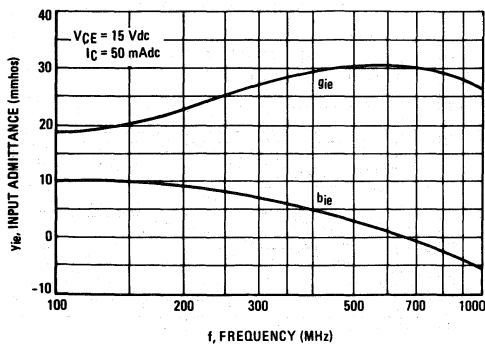


FIGURE 15 — REVERSE TRANSFER ADMITTANCE versus FREQUENCY

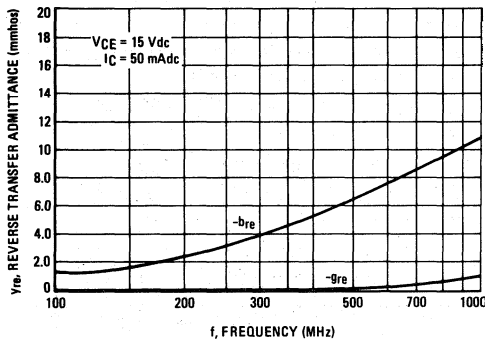


FIGURE 17 — FORWARD TRANSFER ADMITTANCE versus FREQUENCY

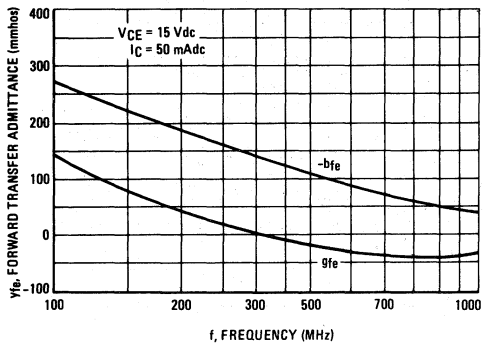


FIGURE 14 — INPUT ADMITTANCE versus COLLECTOR CURRENT

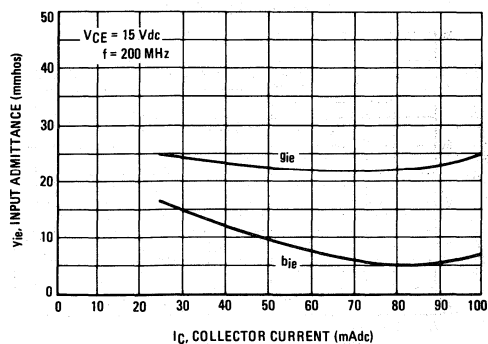


FIGURE 16 — REVERSE TRANSFER ADMITTANCE versus COLLECTOR CURRENT

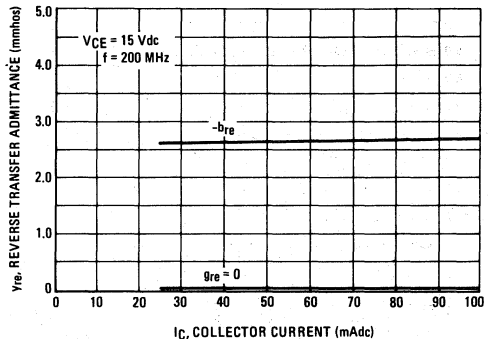


FIGURE 18 — FORWARD TRANSFER ADMITTANCE versus COLLECTOR CURRENT

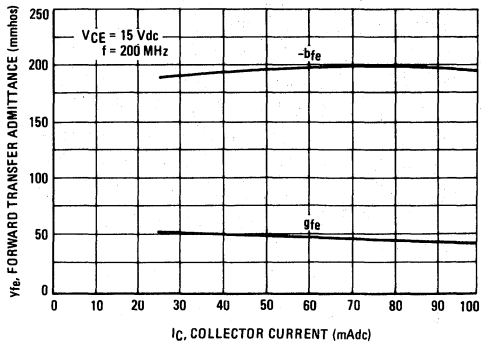


FIGURE 19 – OUTPUT ADMITTANCE versus FREQUENCY

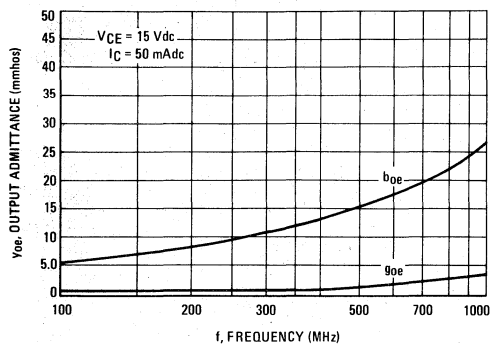


FIGURE 20 – OUTPUT ADMITTANCE versus COLLECTOR CURRENT

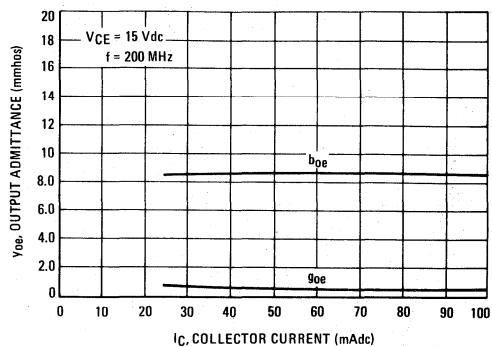


FIGURE 21 – INPUT REFLECTION COEFFICIENT versus FREQUENCY

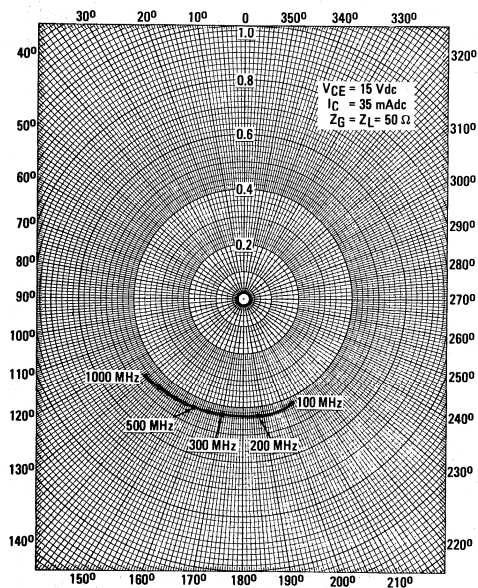


FIGURE 22 – OUTPUT REFLECTION COEFFICIENT versus FREQUENCY

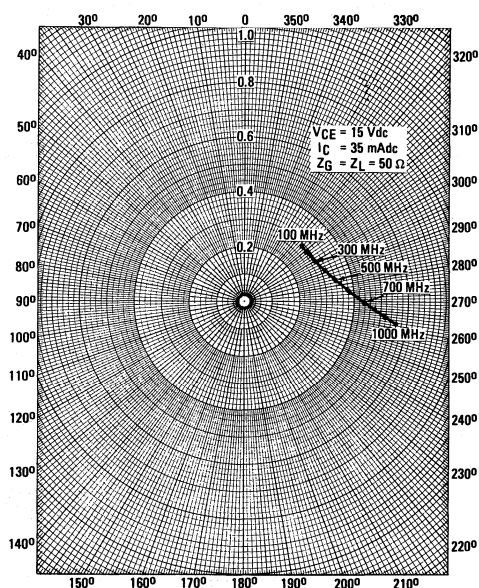


FIGURE 23 – REVERSE TRANSMISSION
COEFFICIENT versus FREQUENCY

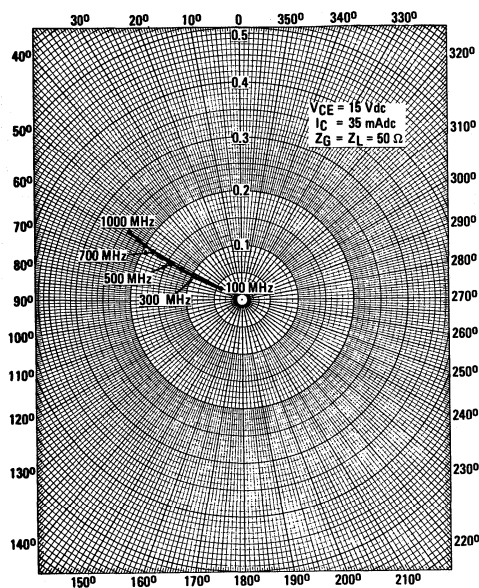


FIGURE 24 – FORWARD TRANSMISSION COEFFICIENT
versus FREQUENCY

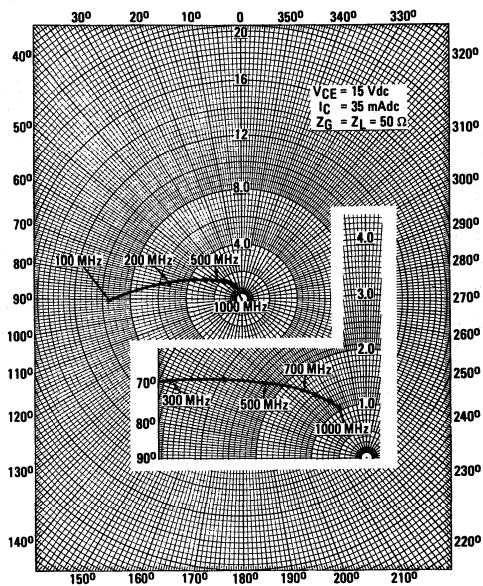
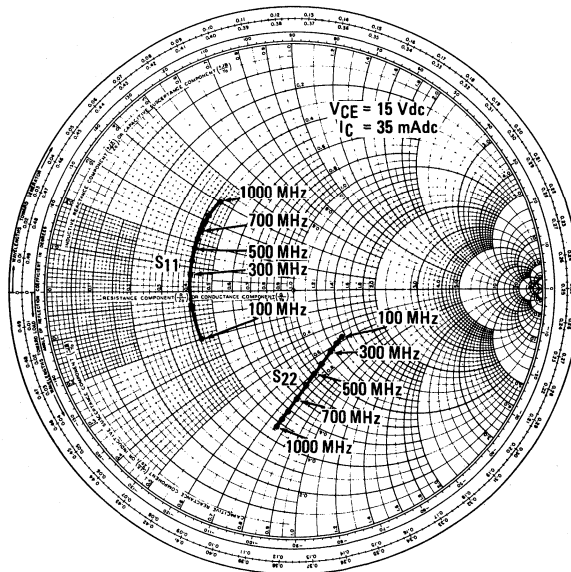


FIGURE 25 – INPUT REFLECTION COEFFICIENT AND OUTPUT REFLECTION
COEFFICIENT versus FREQUENCY



The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed for 7.0 to 15 Volts, UHF large signal amplifier applications required in industrial and commercial FM equipment operating in the 400 to 960 MHz range.

- Specified 12.5 Volt, 470 MHz Characteristics —
 Power Output = 2.0 W — 2N5944
 4.0 W — 2N5945
 10 W — 2N5946
 Minimum Gain = 9.0 dB — 2N5944
 8.0 dB — 2N5945
 6.0 dB — 2N5946
 Efficiency = 60% Minimum
- Characterized with series equivalent large-signal impedance parameters

MAXIMUM RATINGS

Rating	Symbol	2N5944	2N5945	2N5946	Unit
*Collector-Emitter Voltage	V_{CE0}	16			Vdc
*Collector-Base Voltage	V_{CB0}	36			Vdc
*Emitter-Base Voltage	V_{EB0}	4.0			Vdc
*Collector Current — Continuous	I_C	0.4	0.8	2.0	Adc
*Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	5.0 28.5	15 85.5	37.5 214	Watts mW/ $^\circ\text{C}$
*Storage Temperature Range	T_{stg}	-65 to +200			$^\circ\text{C}$
Stud Torque (2)	—	6.5			in-lbs.

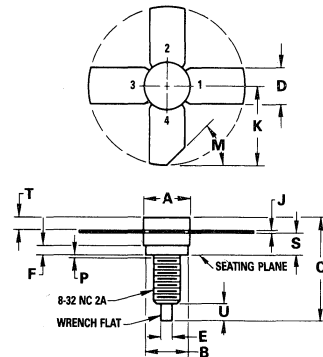
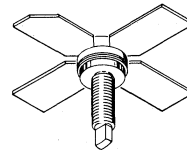
*Indicates JEDEC Registered Data

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(2) For repeated assembly use 5 in-lbs.

2N5944
2N5945
2N5946

2.0, 4.0, 10 W — 470 MHz
 RF POWER
 TRANSISTORS
 NPN SILICON



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

STYLE 1:
 PIN 1. EMITTER
 2. BASE
 3. EMITTER
 4. COLLECTOR

CASE 244-04

2N5944, 2N5945, 2N5946

*ELECTRICAL CHARACTERISTICS ($T_C = 25^{\circ}\text{C}$ unless otherwise noted)

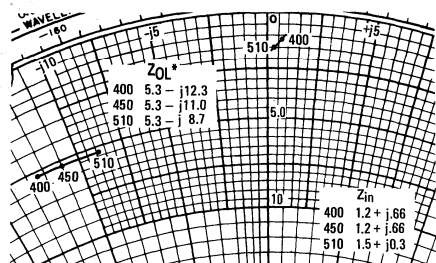
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $I_B = 0$) ($I_C = 100 \text{ mAdc}$, $I_B = 0$) ($I_C = 200 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$ 2N5944 2N5945 2N5946	16 16 16	— — —	— — —	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $V_{BE} = 0$) ($I_C = 100 \text{ mAdc}$, $V_{BE} = 0$) ($I_C = 200 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$ 2N5944 2N5945 2N5946	36 36 36	— — —	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0 \text{ mAdc}$, $I_C = 0$) ($I_E = 2.0 \text{ mAdc}$, $I_C = 0$) ($I_E = 4.0 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$ 2N5944 2N5945 2N5946	4.0 4.0 4.0	— — —	— — —	Vdc
Collector Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $V_{BE} = 0$, $T_C = 55^{\circ}\text{C}$)	I_{CES} 2N5944 2N5945, 2N5946	— —	0.2 0.5	10 20	mAdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$)	I_{CBO} 2N5944, 2N5945 2N5946	— —	— —	1.0 2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$) ($I_C = 200 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$) ($I_C = 500 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE} 2N5944 2N5945 2N5946	20 20 20	80 80 80	— — —	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob} 2N5944 2N5945 2N5946	— — —	11 18 38	15 25 45	pF
FUNCTIONAL TEST (Figures 20 and 21).					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 2.0 \text{ W}$, $I_C(\text{max}) = 267 \text{ mAdc}$, $f = 470 \text{ MHz}$)	G_{PE} 2N5944	9.0	10	—	dB
($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 4.0 \text{ W}$, $I_C(\text{max}) = 533 \text{ mAdc}$, $f = 470 \text{ MHz}$)	2N5945	8.0	9.0	—	
($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 10 \text{ W}$, $I_C(\text{max}) = 1.33 \text{ Adc}$, $f = 470 \text{ MHz}$)	2N5946	6.0	7.0	—	
Collector Efficiency ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 2.0 \text{ W}$, $I_C(\text{max}) = 240 \text{ mAdc}$, $f = 470 \text{ MHz}$)	η 2N5944	60	—	—	%
($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 4.0 \text{ W}$, $I_C(\text{max}) = 500 \text{ mAdc}$, $f = 470 \text{ MHz}$)	2N5945	60	—	—	
($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 10 \text{ W}$, $I_C(\text{max}) = 1.3 \text{ Adc}$, $f = 470 \text{ MHz}$)	2N5946	60	—	—	

*Indicates JEDEC Registered Data

These devices are available in various packages, such as a studless stripline package, TO-205AD (TO-39) and also in chip form on beryllium oxide carriers for hybrid assemblies.
For further information, contact your nearest Motorola representative or the factory representative.

2N5944
TYPICAL PERFORMANCE DATA

FIGURE 1 – SERIES EQUIVALENT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.
 $V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 2.0 \text{ W}$

FIGURE 2 – OUTPUT POWER versus SUPPLY VOLTAGE

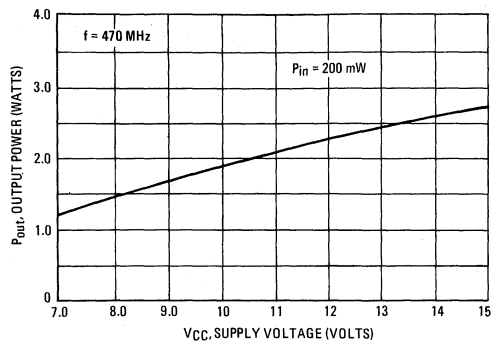


FIGURE 3 – OUTPUT POWER versus INPUT POWER

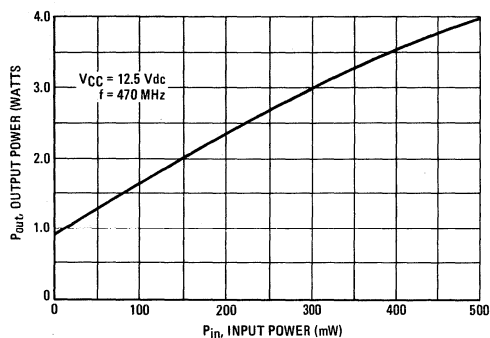


FIGURE 4 – OUTPUT POWER versus FREQUENCY

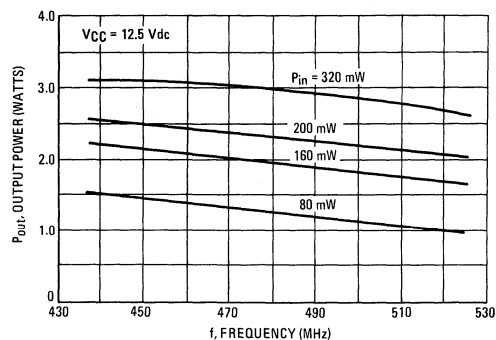


FIGURE 5 – OUTPUT POWER versus INPUT POWER

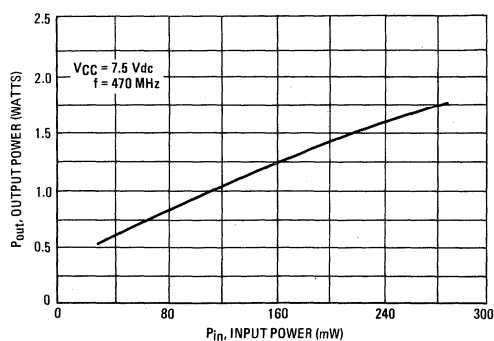
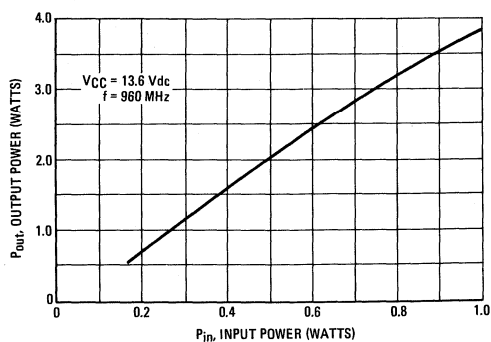


FIGURE 6 – OUTPUT POWER versus INPUT POWER



2N5945
TYPICAL PERFORMANCE DATA

FIGURE 7 — SERIES EQUIVALENT IMPEDANCE

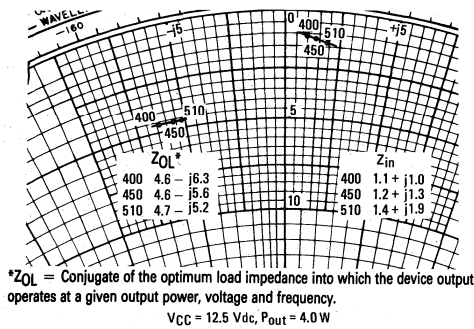


FIGURE 8 — OUTPUT POWER versus SUPPLY VOLTAGE

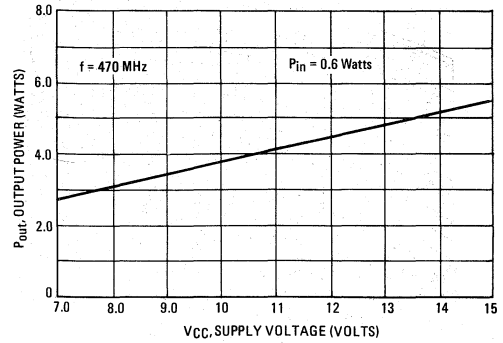


FIGURE 9 — OUTPUT POWER versus INPUT POWER

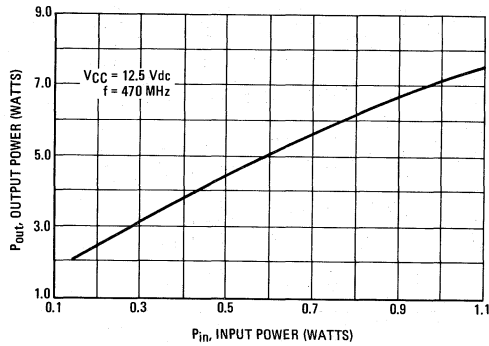


FIGURE 10 — OUTPUT POWER versus FREQUENCY

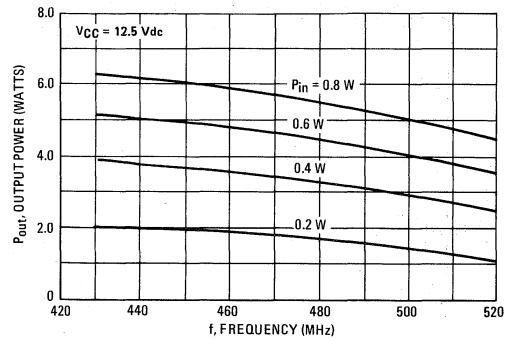


FIGURE 11 — OUTPUT POWER versus INPUT POWER

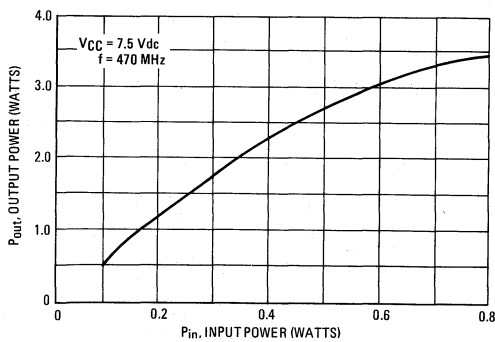
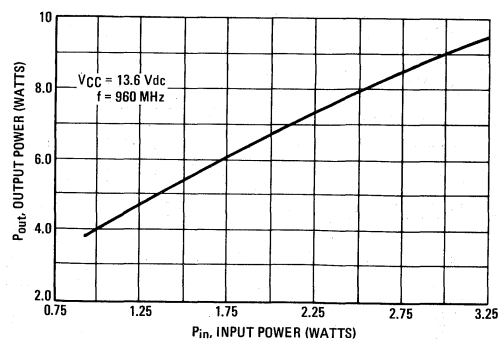


FIGURE 12 — OUTPUT POWER versus INPUT POWER



2N5946
TYPICAL PERFORMANCE DATA

FIGURE 13 — SERIES EQUIVALENT IMPEDANCE

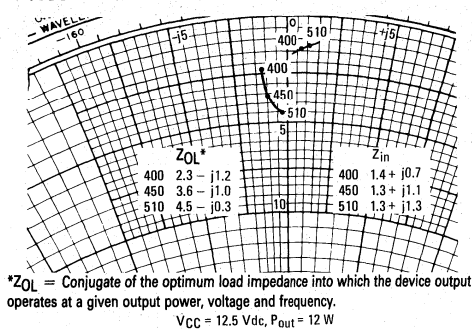


FIGURE 14 — OUTPUT POWER versus SUPPLY VOLTAGE

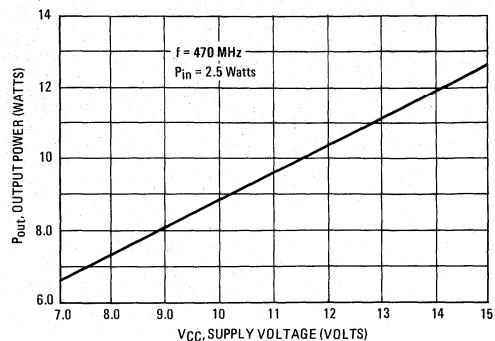


FIGURE 15 — OUTPUT POWER versus INPUT POWER

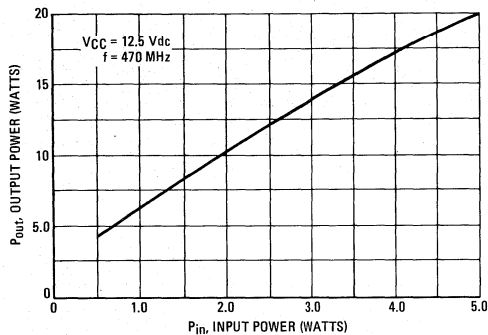


FIGURE 16 — OUTPUT POWER versus FREQUENCY

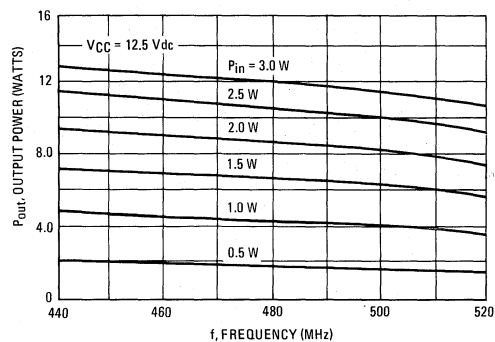


FIGURE 17 — OUTPUT POWER versus INPUT POWER

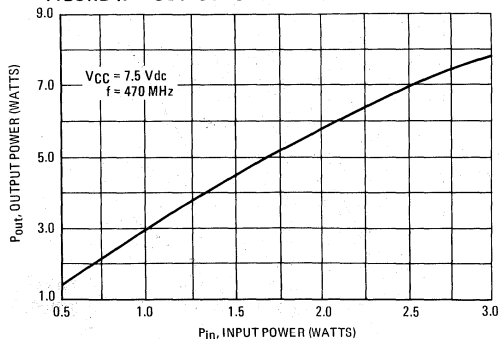
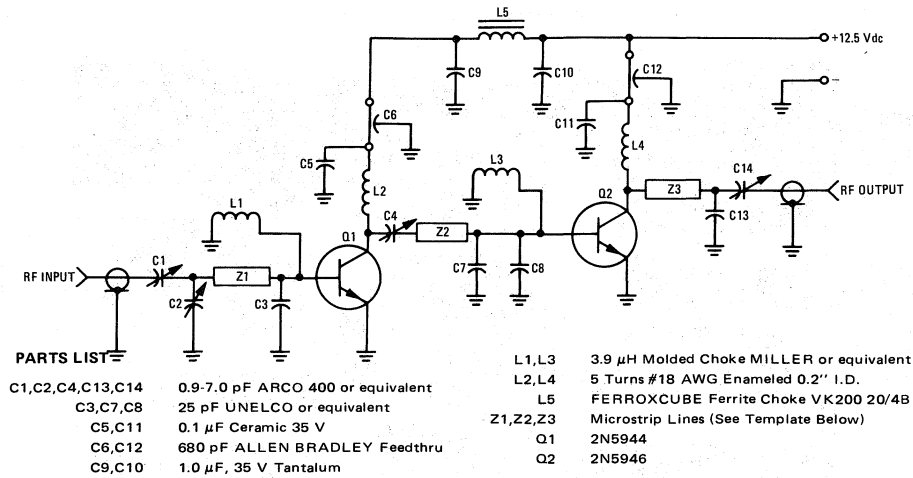


FIGURE 18 — 10-WATT BROADBAND UHF AMPLIFIER



10 W AMPLIFIER PERFORMANCE

$V_{CC} = 12.5$ Vdc

Frequency MHz	P_{in} mW	P_{out} W	I_C Amp
440	250	8.5	1.5
450	250	11	1.6
460	250	12	1.6
470	250	10.9	1.5
480	250	8.2	1.2

FIGURE 19 — OUTPUT POWER versus FREQUENCY

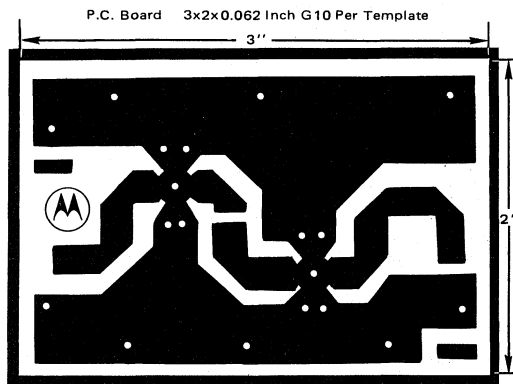
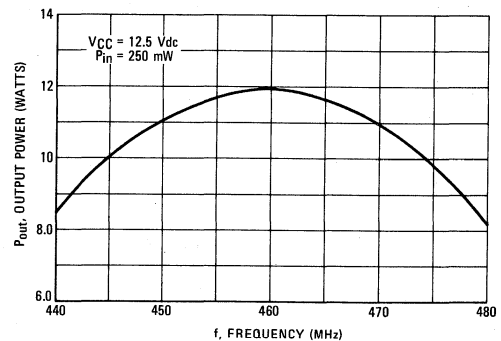


FIGURE 20 — PC BOARD PHOTOMASTER —
10 WATT BROADBAND AMPLIFIER

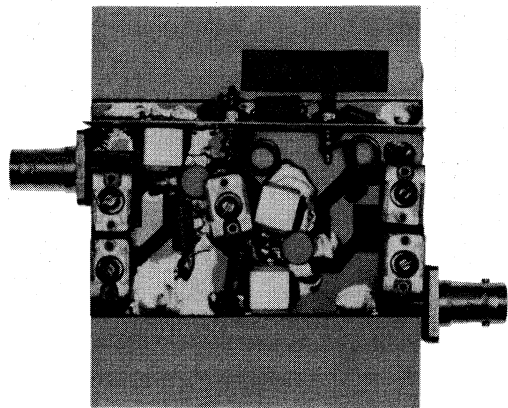
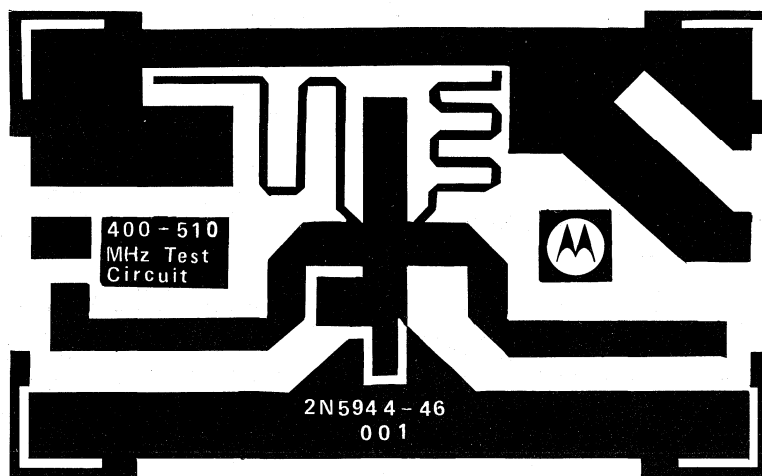
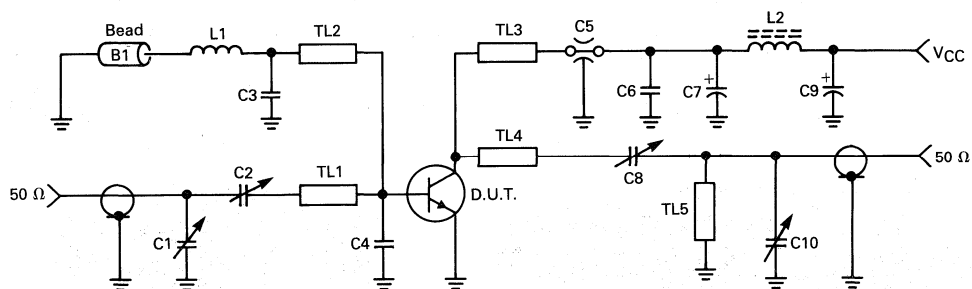


FIGURE 21 — PHOTO OF 10 WATT BROADBAND AMPLIFIER



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 22 — 470 MHz TEST CIRCUIT



C1, C2, C8, C10 — Johanson Trimmer, JMC #5501
 C3 — 100 pF Unelco 350 Vdc J101
 C4 — 15 pF Unelco
 C5 — 680 pF Allen Bradley Feed-Thru
 C6 — 0.1 μ F Monolithic
 C7 — 1 μ F Tantalum Sprague $\pm 10\%$ 35 Vdc
 C9 — 5 μ F Electrolytic 5–25 Vdc

TL1 — Micro Strip 0.26" x 2.9"
 TL2 — Micro Strip 0.055" x 3.9"
 TL3 — Micro Strip 0.055" x 2.9"
 TL4 — Micro Strip 0.26" x 2.9"
 TL5 — Micro Strip 0.50" x 1.2"
 L1 — #18 AWG Wire 0.750" Long
 L2 — VK200 20/4B
 B1 — Ferroxcube Bead, 56-590-65-3B

Board — 0.062" Glass Teflon
 2 oz. Cu CLAD
 $\epsilon_r = 2.55$

FIGURE 23 — 470 MHz TEST CIRCUIT SCHEMATIC

2N6080

The RF Line

NPN SILICON RF POWER TRANSISTOR

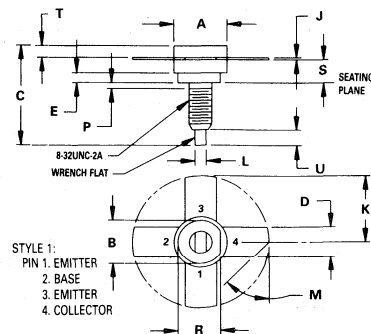
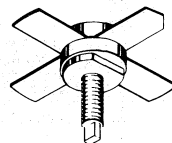
... designed for 12.5 Volt VHF large-signal power amplifier applications required in military and industrial equipment operating to 300 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
Output Power = 4.0 W
Minimum Gain = 12 dB
Efficiency = 50%
- Characterized with Series Equivalent Large-Signal Impedance Parameters

4.0 W — 175 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	A _{dc}
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (2) Derate above 25°C	P_D	12 68.5	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$
Stud Torque (1)	—	6.5	in. lb.

*Indicates JEDEC Registered Data.

(1) For repeated assembly use 5 in. lb.

(2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

***ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = +55^\circ\text{C}$)	I_{CES}	—	—	5.0	mA
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.25	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 0.25\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ MHz}$)	C_{ob}	—	15	20	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($P_{out} = 4.0\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{PE}	12	—	—	dB
Collector Efficiency ($P_{out} = 4.0\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	η	50	—	—	%

*Indicates JEDEC Registered Data.

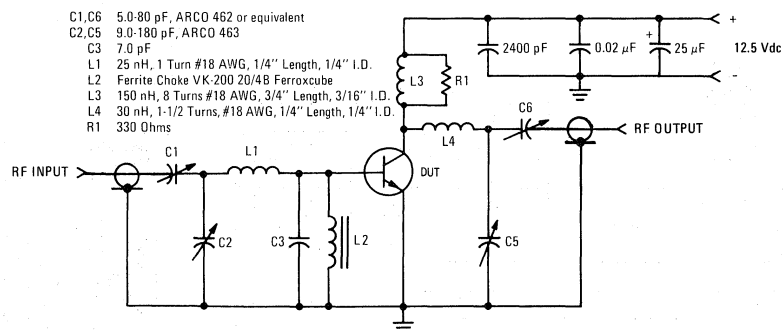
FIGURE 1 — 175 MHz TEST CIRCUIT

FIGURE 2 – OUTPUT POWER versus INPUT POWER

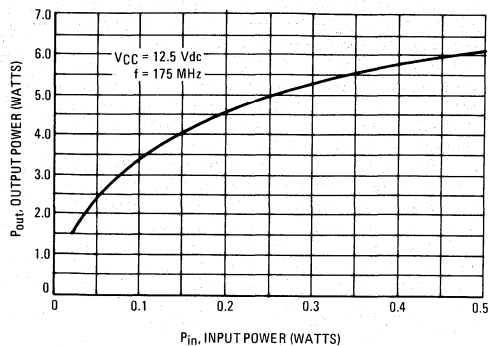


FIGURE 3 – OUTPUT POWER versus FREQUENCY

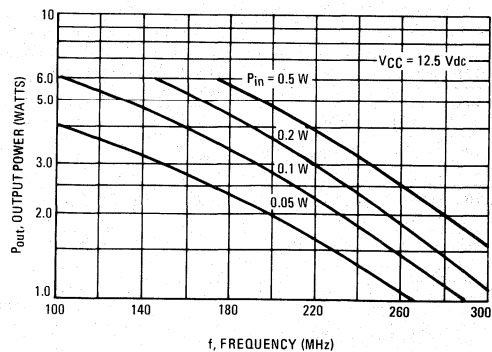


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

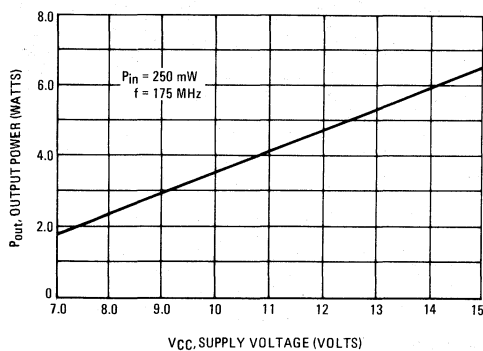
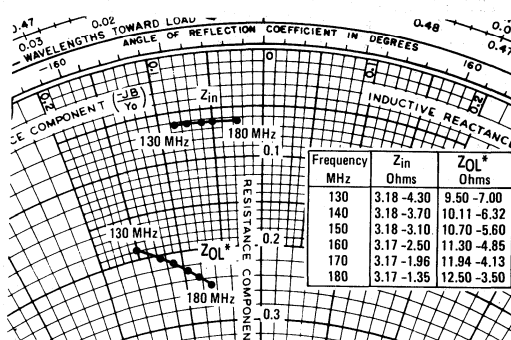


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed for 12.5 Volt VHF large-signal power amplifier applications required in commercial and industrial equipment operating to 300 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
Output Power = 15 W
Minimum Gain = 6.3 dB
Efficiency = 60%
- Characterized with Series Equivalent Large-Signal Impedance Parameters

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	31 177	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C
Stud Torque (2)	—	6.5	in. lb.

*Indicates JEDEC Registered Data for 2N6081.

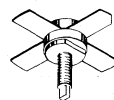
- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) For repeated assembly use 5 in. lb.

2N6081 MRF221

15 W — 175 MHz

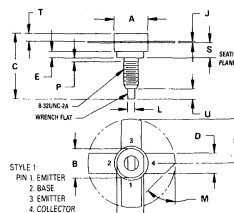
RF POWER TRANSISTORS NPN SILICON

2N6081



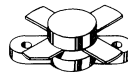
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.75	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.48	5.87	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.



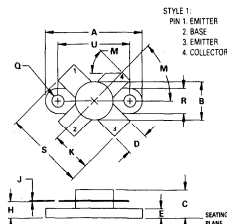
CASE 145A-09

MRF221



DIM	MILLIMETERS			INCHES		
	MIN	MAX		MIN	MAX	
A	24.39	25.14		0.960	0.99	
B	9.40	9.90		0.370	0.39	
C	5.82	7.13		0.229	0.28	
D	5.47	5.86		0.215	0.23	
E	2.16	2.66		0.085	0.105	
H	3.81	4.57		0.150	0.18	
J	0.11	0.15		0.004	0.005	
K	10.04	10.28		0.395	0.405	
M	45°	50°		45°	50°	
Q	2.88	3.30		0.113	0.13	
R	6.23	6.47		0.245	0.25	
S	20.07	20.57		0.790	0.81	
U	18.28	18.54		0.720	0.73	

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.



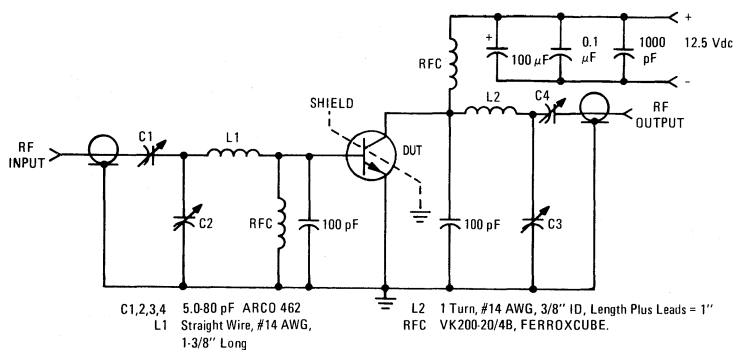
CASE 211-07

***ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = +55^\circ\text{C}$)	I_{CES}	—	—	8.0	mAdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 0.5\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ MHz}$)	C_{ob}	—	70	85	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($P_{out} = 15\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{PE}	6.3	—	—	dB
Collector Efficiency ($P_{out} = 15\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	η	60	—	—	%

*Indicates JEDEC Registered Data for 2N6081.

FIGURE 1 — 175 MHz TEST CIRCUIT



2

FIGURE 2 – OUTPUT POWER versus INPUT POWER

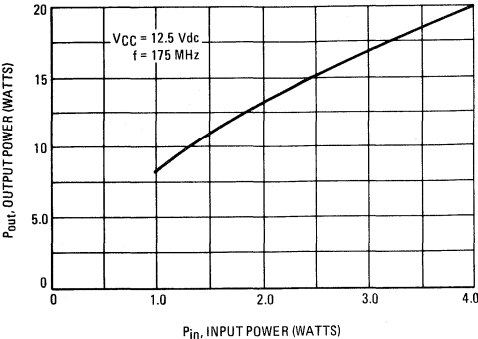


FIGURE 3 – OUTPUT POWER versus FREQUENCY

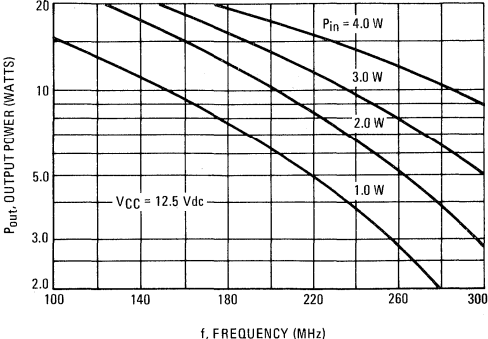


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

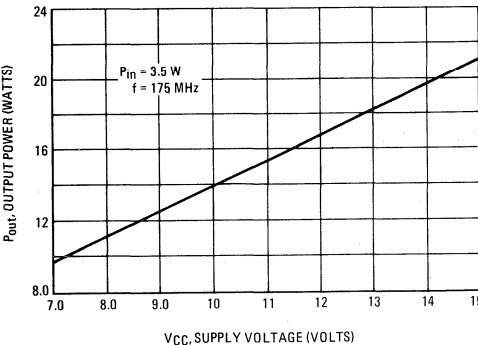
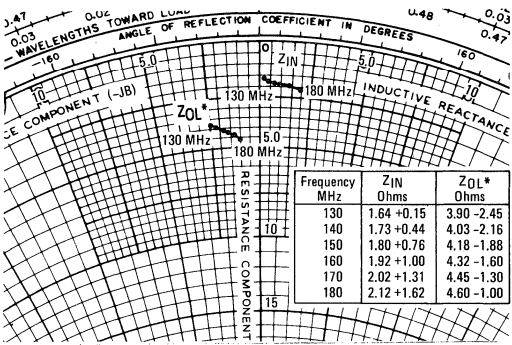


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2N6082

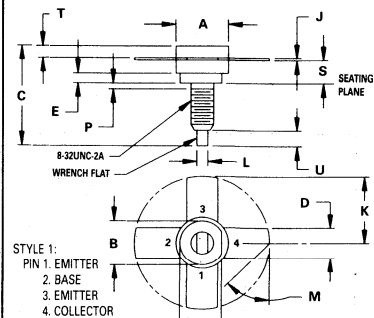
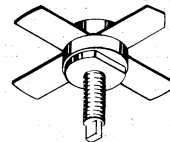
The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed for 12.5 Volt VHF large-signal amplifier applications required in commercial and industrial equipment operating to 300 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
 Output Power = 25 W
 Minimum Gain = 6.2 dB
 Efficiency = 65%

25 W — 175 MHz
RF POWER
TRANSISTOR
NPN SILICON



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM	45° NOM	—	—
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (2) Derate above 25°C	P_D	65 .37	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C
Stud Torque(1)	—	6.5	in.lb.

*Indicates JEDEC Registered Data for 2N6082.

(1) For Repeated Assembly Use 5 in. lb.

(2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 15\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = +55^\circ\text{C}$)	I_{CES}	—	—	10	mA
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ MHz}$)	C_{ob}	—	110	130	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($P_{out} = 25\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{PE}	6.2	—	—	dB
Collector Efficiency ($P_{out} = 25\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	η	65	—	—	%

*Indicates JEDEC Registered Data for 2N6082.

FIGURE 1 — 175 MHz TEST CIRCUIT

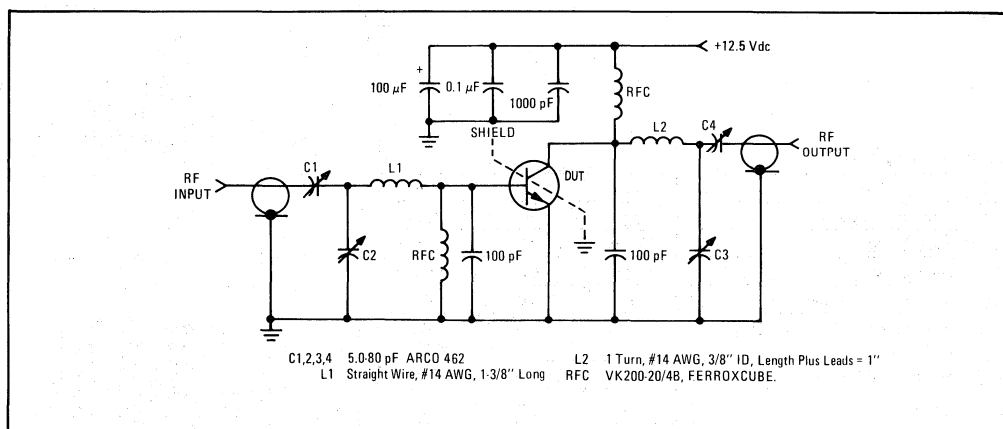


FIGURE 2 – OUTPUT POWER versus INPUT POWER

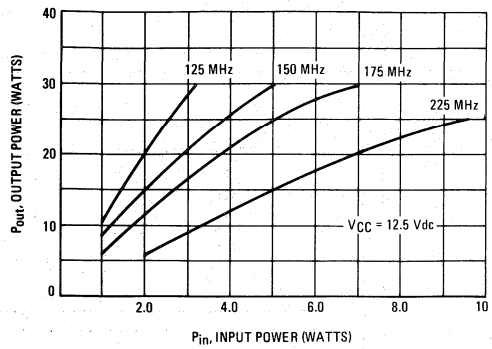


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

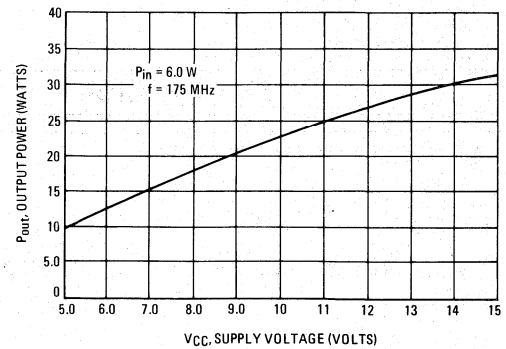
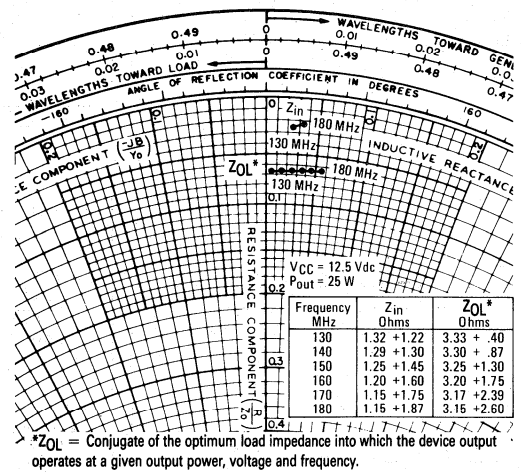


FIGURE 4 – SERIES EQUIVALENT IMPEDANCE



2N6083

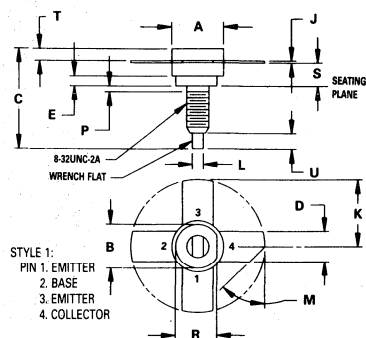
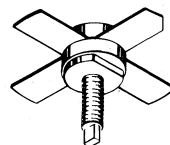
The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed for 12.5 Volt VHF large-signal amplifier applications required in commercial and industrial equipment operating to 300 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
 Output Power = 30 W
 Minimum Gain = 5.7 dB
 Efficiency = 65%

30 W — 175 MHz
RF POWER
TRANSISTOR
NPN SILICON



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (2) Derate above 25°C	P_D	65 .37	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C
Stud Torque(1)	—	6.5	in.lb.

*Indicates JEDEC Registered Data for 2N6083.

(1) For Repeated Assembly Use 5 in. lb.

(2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

***ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 15\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = +55^\circ\text{C}$)	I_{CES}	—	—	10	mAdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ MHz}$)	C_{ob}	—	110	130	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($P_{out} = 30\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{PE}	5.7	—	—	dB
Collector Efficiency ($P_{out} = 30\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	η	65	—	—	%

* Indicates JEDEC Registered Data for 2N6083.

FIGURE 1 – 175 MHz TEST CIRCUIT

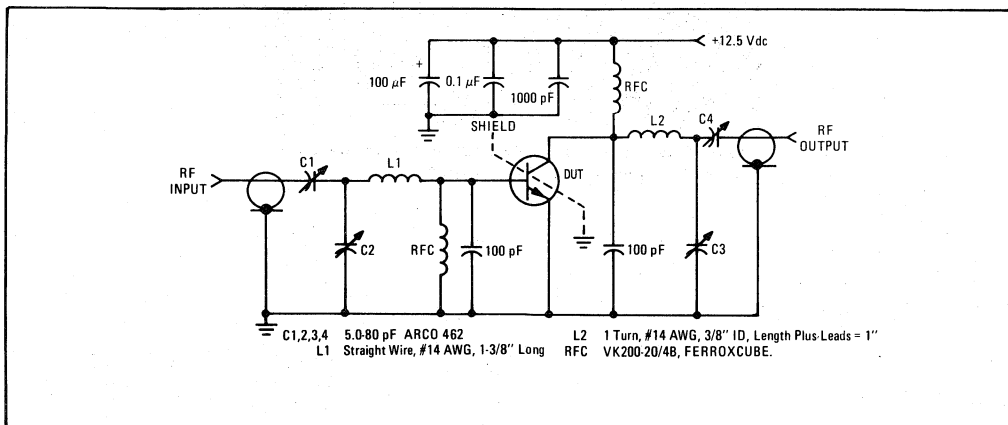


FIGURE 2 — OUTPUT POWER versus INPUT POWER

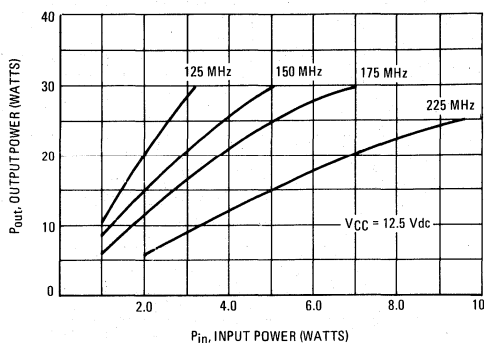


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

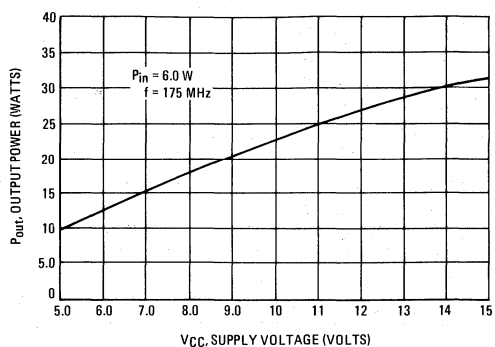
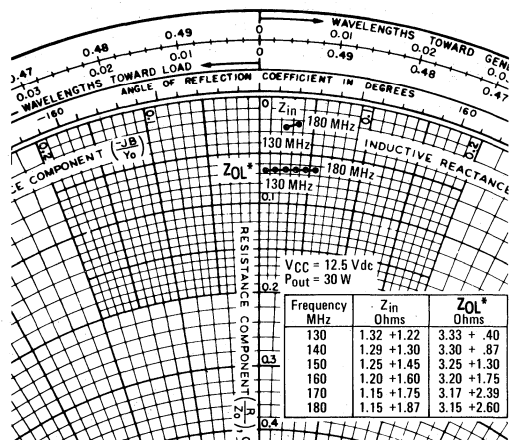


FIGURE 4 — SERIES EQUIVALENT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed for 12.5 Volt VHF large-signal amplifier applications required in commercial and industrial equipment operating to 300 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
Output Power = 40 W
Minimum Gain = 4.5 dB
Efficiency = 70%

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	7.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (2) Derate above 25°C	P_D	80 .46	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C
Stud Torque(1)	—	6.5	in.lb.

*Indicates JEDEC Registered Data for 2N6084.

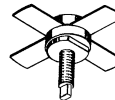
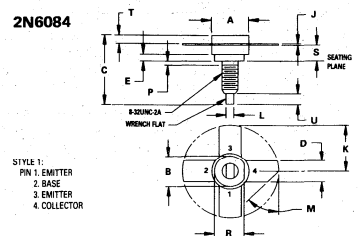
(1) For Repeated Assembly Use 5 in. lb.

(2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

2N6084
MRF224

40 W — 175 MHz
RF POWER
TRANSISTORS
NPN SILICON

2N6084

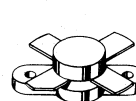
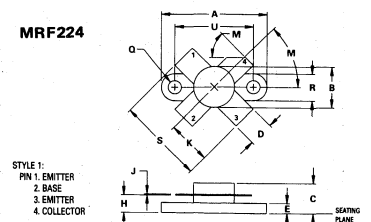


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.98	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM	—	45° NOM	—
P	—	1.27	—	0.050
R	7.39	7.60	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.95	0.098	0.152

CASE 145A-09

MRF224



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.54	10.78	0.415	0.425
M	45°	50°	45°	50°
Q	2.88	3.30	0.113	0.130
R	6.73	6.47	0.265	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = +55^\circ\text{C}$)	I_{CES}	—	—	10	mA
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	2.5	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ MHz}$)	C_{ob}	—	170	200	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($P_{out} = 40\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{pE}	4.5	—	—	dB
Collector Efficiency ($P_{out} = 40\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	η	70	—	—	%

*Indicates JEDEC Registered Data for 2N6084.

FIGURE 1 — 175 MHz TEST CIRCUIT

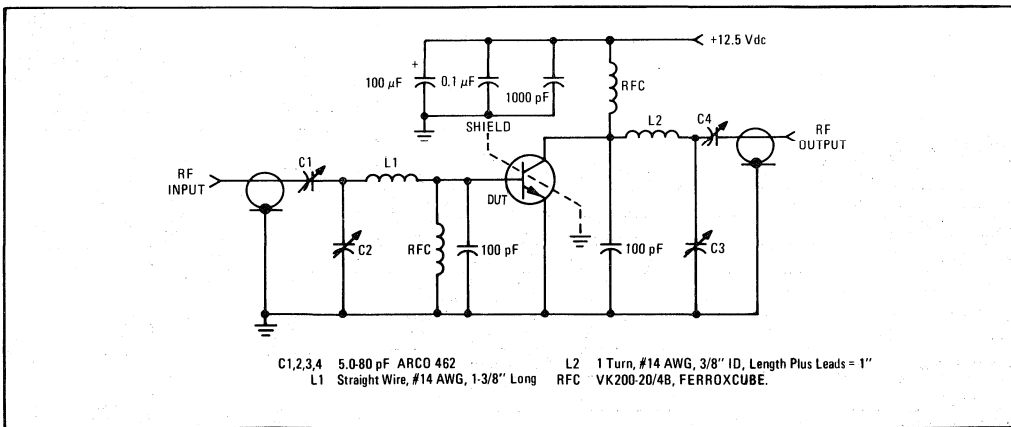


FIGURE 2 – OUTPUT POWER versus INPUT POWER

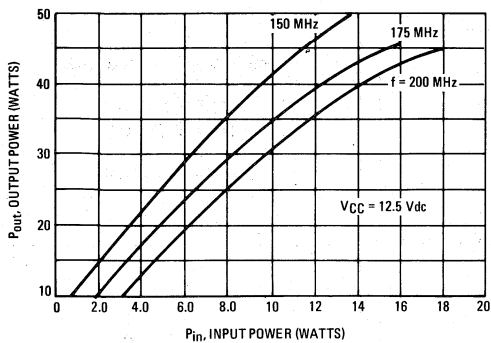


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

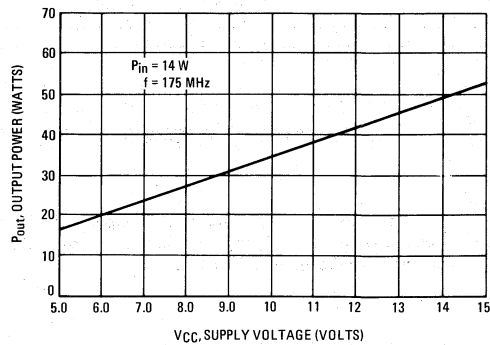
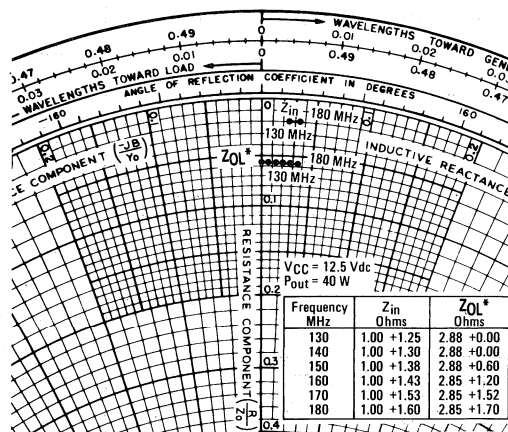


FIGURE 4 – SERIES EQUIVALENT IMPEDANCE



* Z_{OL}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2N6166

The RF Line

NPN SILICON RF POWER TRANSISTOR

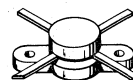
... designed for VHF power amplifier applications in military and industrial equipment. Particularly suited for use in Class AB, B, or C amplifier applications to 200 MHz

- Specified 28-Volt, 150-MHz Characteristics —
Output Power = 100 Watts
Minimum Gain = 6.0 dB
Efficiency = 60%
- Specified 13.5-Volt, 150 MHz Characteristics —
Output Power = 30 Watts
Minimum Gain = 4.5 dB
- Parallel Impedance Characterization

100 WATTS — 150 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



***MAXIMUM RATINGS**

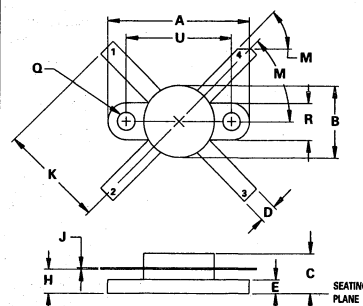
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	9.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	117 0.667	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.5	$^\circ\text{C}/\text{W}$

*Indicates JEDEC Registered Data.

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	2.16	3.93	0.085	0.155
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	17.78	—	0.700	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.23	6.47	0.245	0.255
U	18.29	18.54	0.720	0.730

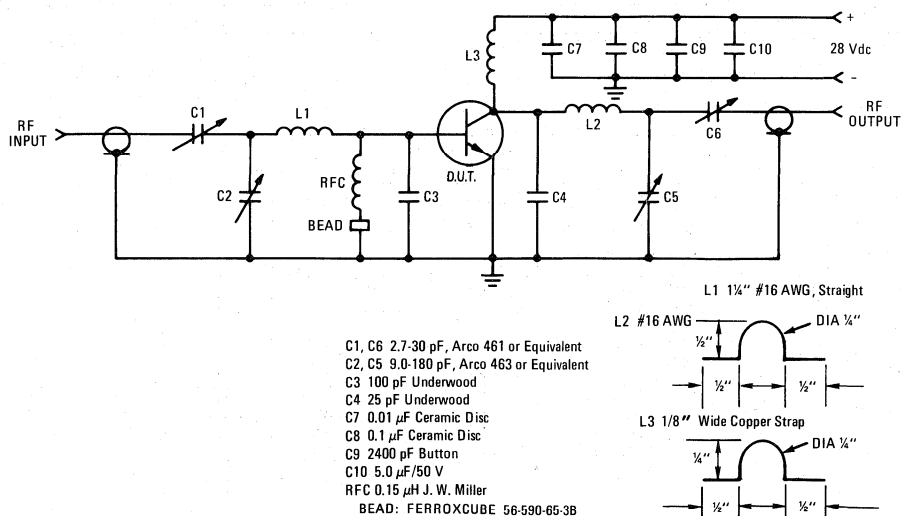
CASE 211-10

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{BE} = 0$, $T_C = 55^\circ\text{C}$)	I_{CES}	—	5.0	mA
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	3.0	mA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—
DYNAMIC CHARACTERISTICS				
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	130	pF
FUNCTIONAL TEST				
Common-Emitter Amplifier Power Gain ($P_{out} = 100\text{ W}$, $V_{CC} = 28\text{ Vdc}$, $I_C(\text{Max}) = 5.95\text{ A}$, $f = 150\text{ MHz}$)	G_{PE}	6.0	—	dB
Common-Emitter Amplifier Power Gain ($P_{out} = 30\text{ W}$, $V_{CC} = 13.5\text{ V}$, $f = 150\text{ MHz}$)	G_{PE}	4.5	—	dB
Collector Efficiency ($P_{out} = 100\text{ W}$, $V_{CC} = 28\text{ Vdc}$, $I_C(\text{Max}) = 5.95\text{ A}$, $f = 150\text{ MHz}$)	η	60	—	%

*Indicates JEDEC Registered Data.

FIGURE 1 — 150 MHz TEST CIRCUIT



OUTPUT POWER versus FREQUENCY

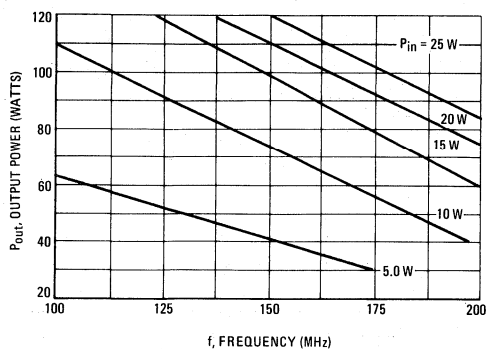
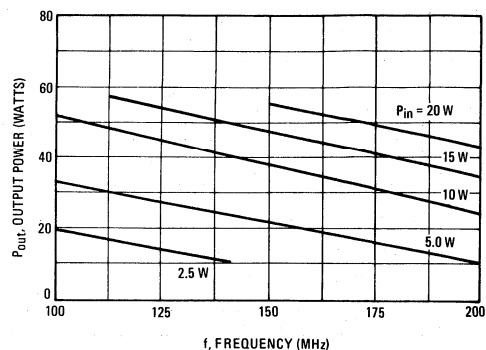
FIGURE 2 - $V_{CC} = 28 \text{ Vdc}$ FIGURE 3 - $V_{CC} = 13.5 \text{ Vdc}$ 

FIGURE 4 - OUTPUT POWER versus INPUT POWER

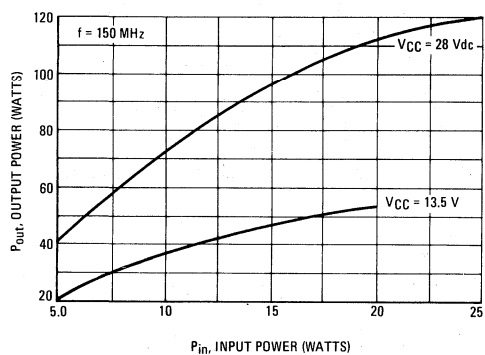


FIGURE 5 - OUTPUT POWER versus SUPPLY VOLTAGE

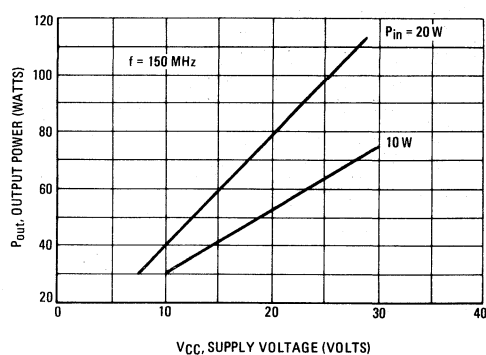
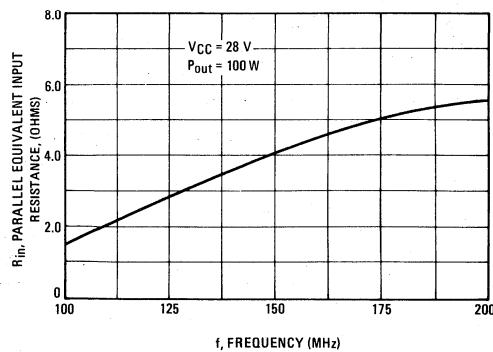
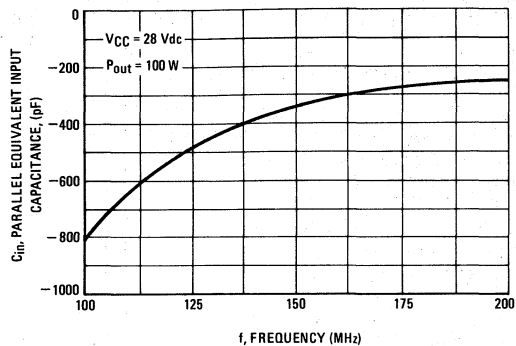
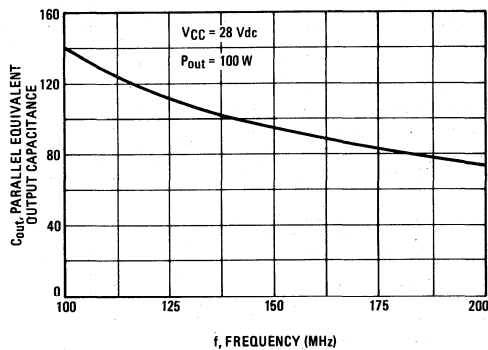


FIGURE 6 - PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY



**FIGURE 7 – PARALLEL EQUIVALENT INPUT CAPACITANCE
versus FREQUENCY****FIGURE 8 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE
versus FREQUENCY**

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

... designed for use as low-noise, high-gain, general-purpose amplifiers.

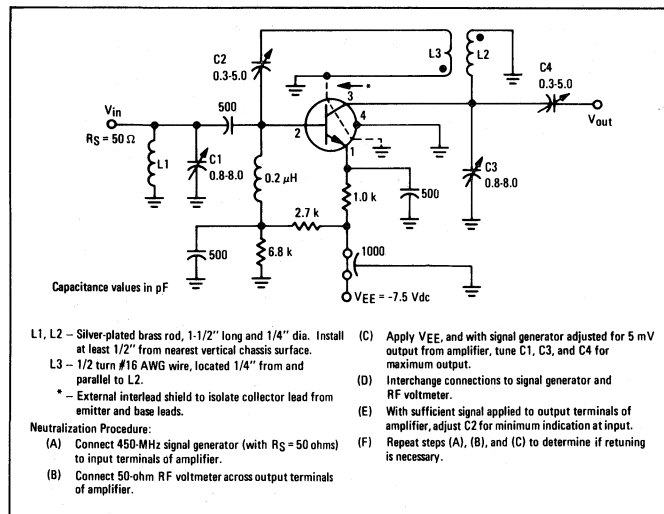
- High Current-Gain — Bandwidth Product —
 $f_T = 1.4 \text{ GHz (Min) @ } I_C = 10 \text{ mA dc} - 2N6304$
 $= 1.2 \text{ GHz (Min) @ } I_C = 10 \text{ mA dc} - 2N6305$
- Low Noise Figure —
 $NF = 4.5 \text{ dB (Max) @ } f = 450 \text{ MHz} - 2N6304$
 $= 5.5 \text{ dB (Max) @ } f = 450 \text{ MHz} - 2N6305$
- High Power Gain —
 $G_{pe} = 15 \text{ dB (Min) @ } f = 450 \text{ MHz} - 2N6304$
 $= 12 \text{ dB (Min) @ } f = 450 \text{ MHz} - 2N6305$

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage 1.0 to 20 mA dc	V_{CEO}	15	V dc
Collector-Base Voltage	V_{CBO}	30	V dc
Emitter-Base Voltage	V_{EBO}	3.0	V dc
Collector Current Continuous	I_C	50	mA dc
Total Continuous Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	200 1.14	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

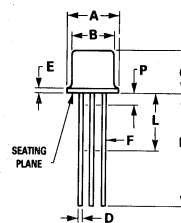
FIGURE 1 — TEST CIRCUIT FOR NOISE FIGURE AND POWER GAIN



2N6304
2N6305

1.4 GHz @ 10 mA dc — 2N6304
1.2 GHz @ 10 mA dc — 2N6305

HIGH FREQUENCY
TRANSISTORS
NPN SILICON



STYLE 10:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

*ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	nAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	25	—	250	—
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DYNAMIC CHARACTERISTICS

Current-Gain-Bandwidth Product ($I_C = 10\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$, $f = 100\text{ MHz}$)	2N6304 2N6305	f_T	1400 1200	— —	— —	MHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)		C_{cb}	—	0.8	1.0	pF
Small-Signal Current Gain ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$, $f = 1.0\text{ kHz}$)		h_{fe}	25	—	250	—
Collector-Base Time Constant ($I_E = 2.0\text{ mAdc}$, $V_{CB} = 5.0\text{ Vdc}$, $f = 31.8\text{ MHz}$)	2N6304 2N6305	$r_b'C_c$	2.0 2.0	—	12 15	ps
Noise Figure ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$, $R_S = 50\text{ ohms}$, $f = 450\text{ MHz}$) (Figure 1)	2N6304 2N6305	NF	— —	— —	4.5 5.5	dB

FUNCTIONAL TEST

Common-Emitter Amplifier Power Gain ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$, $f = 450\text{ MHz}$) (Figure 1)	2N6304 2N6305	G_{pe}	15 12	— —	— —	dB
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*Indicates JEDEC Registered Data.

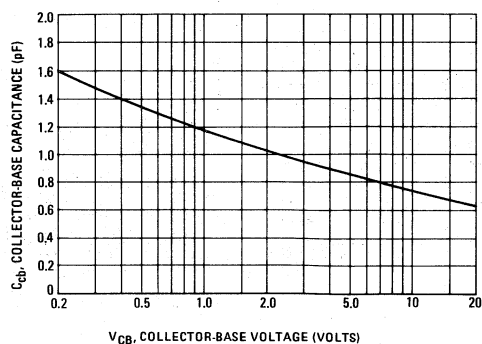
**FIGURE 2 — COLLECTOR-BASE CAPACITANCE
versus COLLECTOR BASE VOLTAGE**

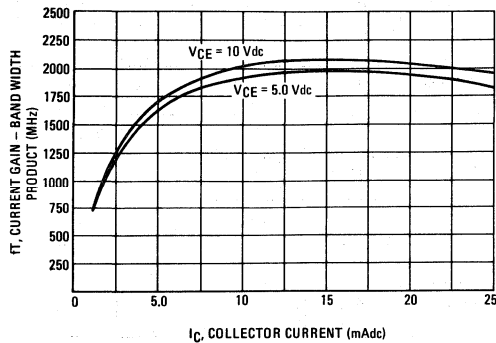
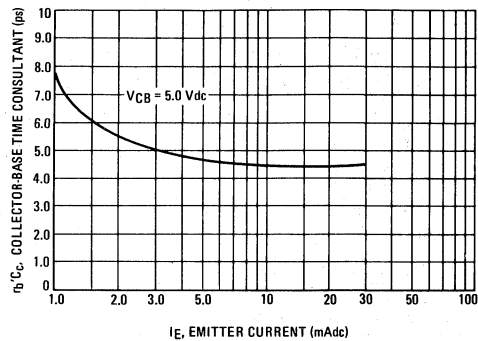
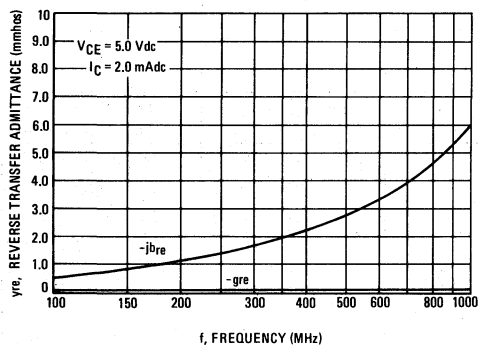
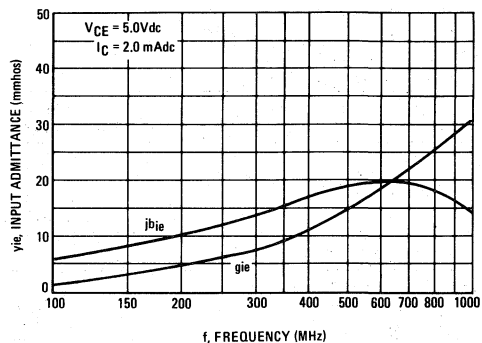
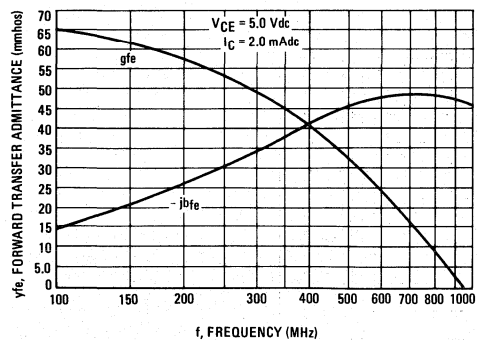
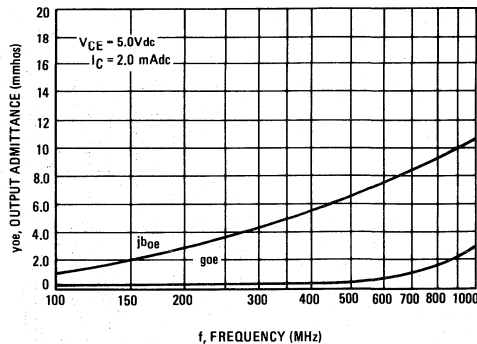
FIGURE 3 – CURRENT-GAIN-BANDWIDTH
PRODUCT versus COLLECTOR CURRENTFIGURE 4 – COLLECTOR-BASE TIME
CONSTANT versus EMITTER CURRENTFIGURE 5 – REVERSE TRANSFER
ADMITTANCE versus FREQUENCYFIGURE 6 – INPUT ADMITTANCE
versus FREQUENCYFIGURE 7 – OUTPUT ADMITTANCE
versus FREQUENCYFIGURE 8 – FORWARD TRANSFER
ADMITTANCE versus FREQUENCY

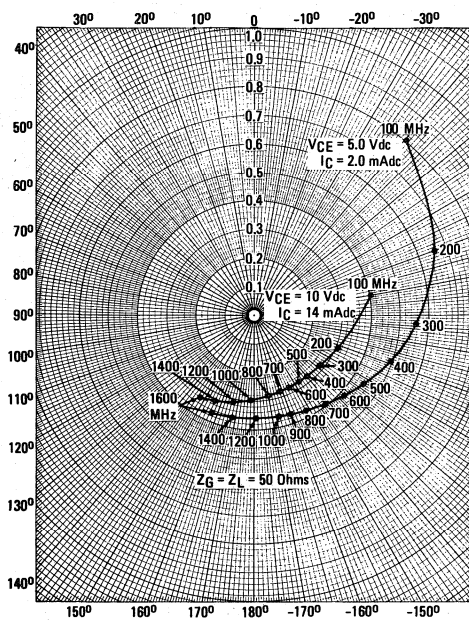
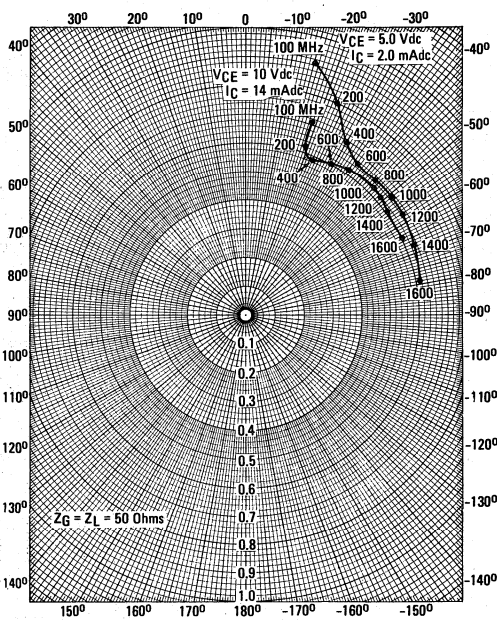
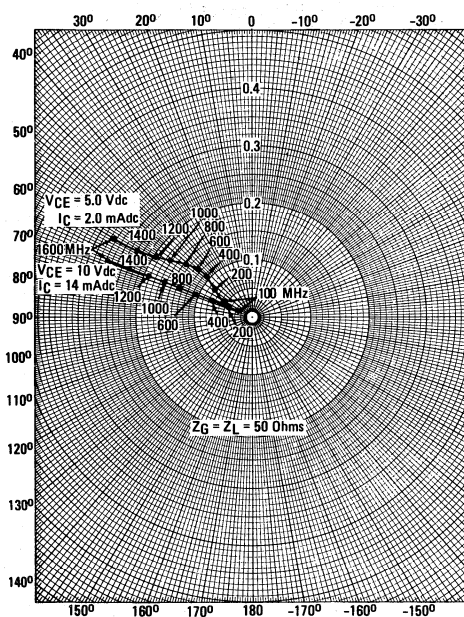
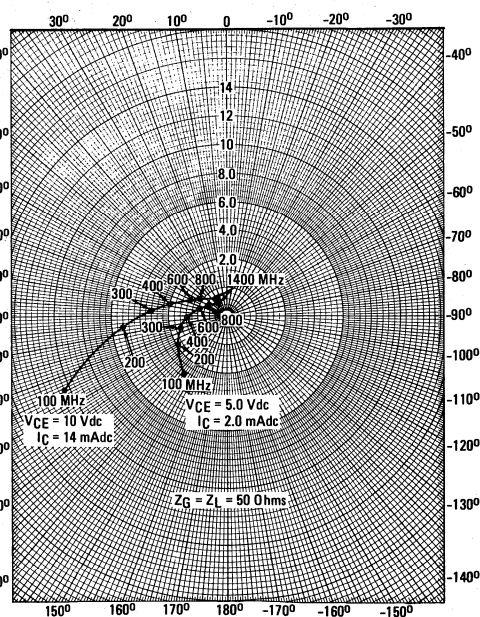
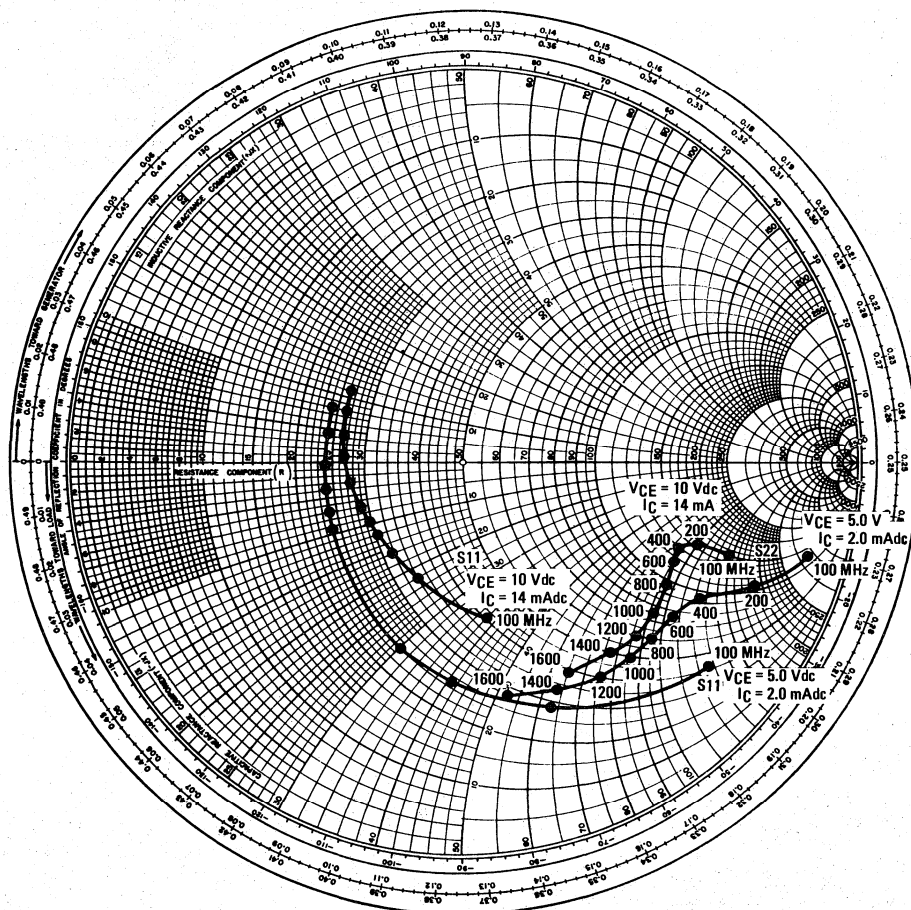
FIGURE 9 — S_{11} , INPUT REFLECTION COEFFICIENTFIGURE 10 — S_{22} , OUTPUT REFLECTION COEFFICIENTFIGURE 11 — S_{12} , REVERSE TRANSMISSION COEFFICIENTFIGURE 12 — S_{21} , FORWARD TRANSMISSION COEFFICIENT

FIGURE 13 — S_{11} , INPUT REFLECTION COEFFICIENT AND S_{22} , OUTPUT REFLECTION COEFFICIENT

2N6439

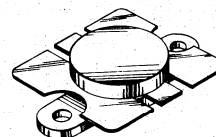
The RF Line

NPN SILICON RF POWER TRANSISTOR

...designed primarily for wideband large-signal output amplifier stages in the 225-400 MHz frequency range.

- **Guaranteed Performance in 225–400 MHz Broadband Amplifier @ 28 Vdc**
Output Power = 60 Watts over 225–400 MHz Band
Minimum Gain = 7.8 dB @ 400 MHz
- **Built-In Matching Network for Broadband Operation Using Double Match Technique**
- **100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR**
- **Gold Metallization System for High Reliability Applications**

60 W – 225–400 MHz
CONTROLLED “Q”
BROADBAND RF POWER
TRANSISTOR
NPN SILICON



***MAXIMUM RATINGS**

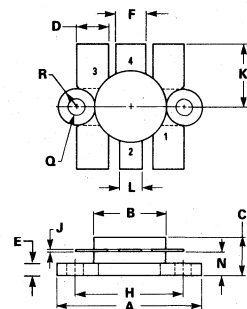
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	146 0.83	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.2	$^\circ\text{C}/\text{W}$

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

* Indicates JEDEC Registered Data.



STYLE 1:
PIN 1: EMITTER
PIN 2: COLLECTOR
PIN 3: EMITTER
PIN 4: BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

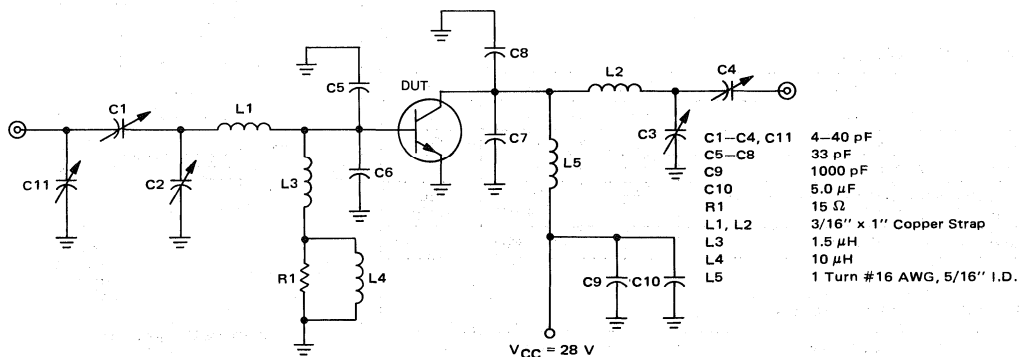
CASE 316-01

***ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	2.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	67	75	pF
BROADBAND FUNCTIONAL TESTS (Figure 6)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 60\text{ W}$, $f = 225\text{--}400\text{ MHz}$)	G_{pE}	7.8	8.5	—	dB
Electrical Ruggedness ($P_{out} = 60\text{ W}$, $V_{CC} = 28\text{ Vdc}$, $f = 400\text{ MHz}$, VSWR 30:1 all phase angles)	—	No Degradation in P_{out}			—
NARROW BAND FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$)	G_{pE}	7.8	10	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$)	η	55	—	—	%

* Indicates JEDEC Registered Data.

FIGURE 1 — 400 MHz TEST AMPLIFIER (NARROW BAND)



NARROW BAND DATA

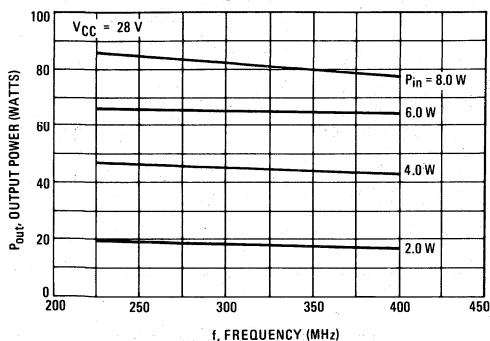
FIGURE 2 — P_{out} versus FREQUENCY

FIGURE 3 — OUTPUT POWER versus INPUT POWER

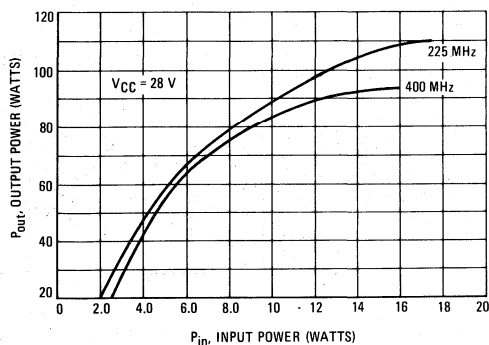


FIGURE 4 — POWER-GAIN versus FREQUENCY

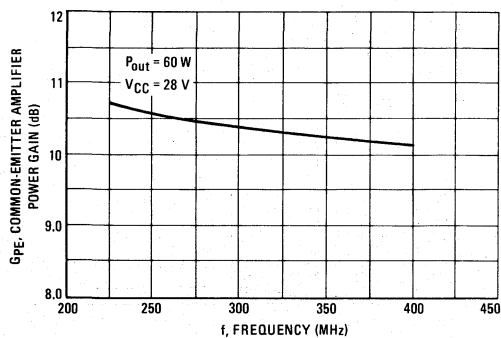


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE

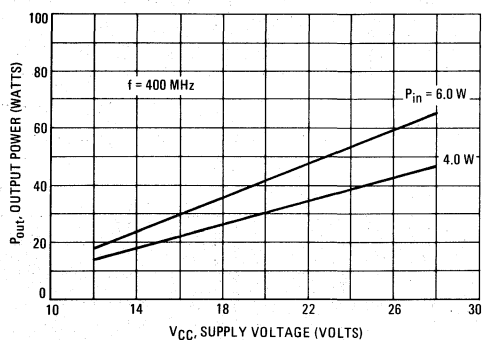


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE

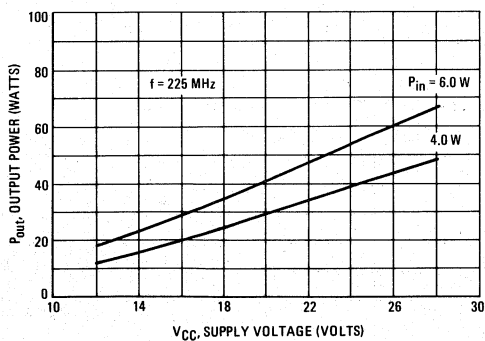
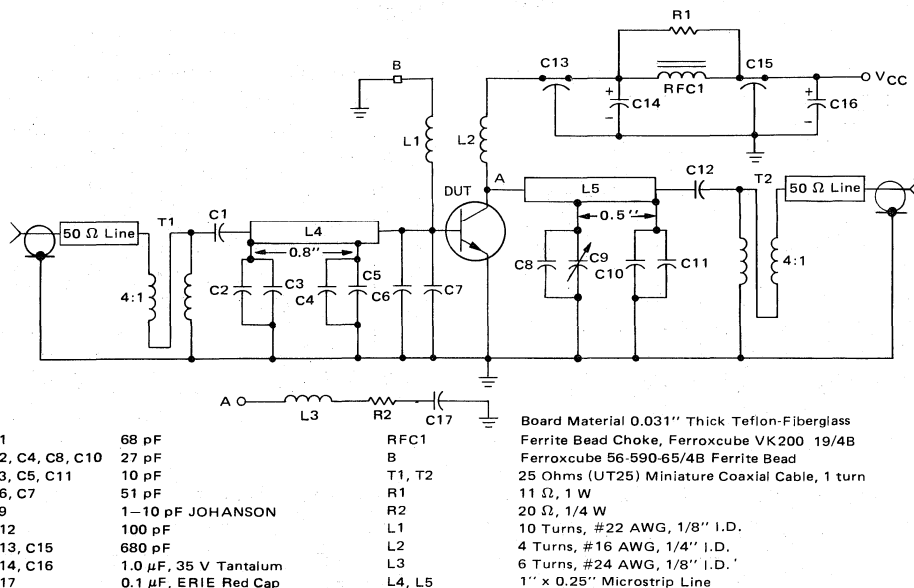


FIGURE 7 — 225-400 MHz BROADBAND TEST CIRCUIT SCHEMATIC



BROADBAND DATA (Circuit, Figure 7)

FIGURE 8 — POWER GAIN versus FREQUENCY

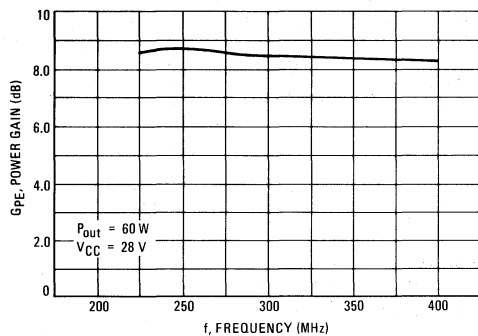


FIGURE 9 — EFFICIENCY versus FREQUENCY

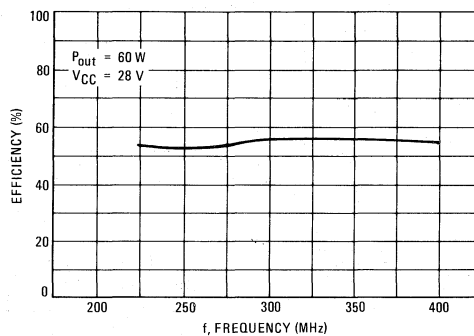


FIGURE 10 — INPUT VSWR versus FREQUENCY

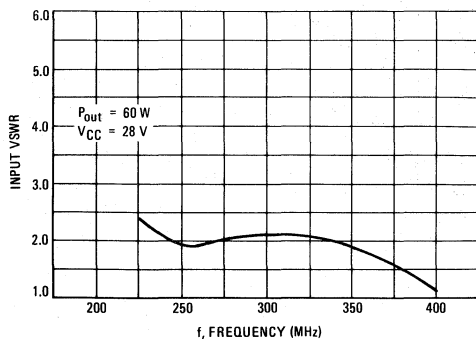
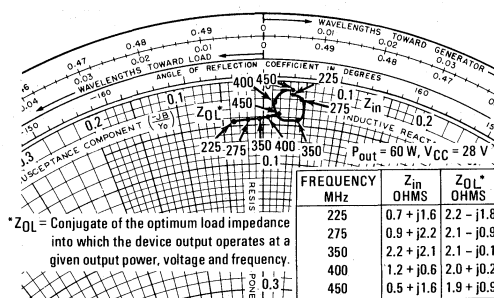


FIGURE 11 — SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



2N6603

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed for use in high-gain, low-noise, small signal, narrow and wideband amplifiers. Ideal for use in microstrip thin and thick film applications.

- Low Noise Figure —
 $NF = 2.0 \text{ dB (Typ) @ } f = 1.0 \text{ GHz}$
 $= 2.9 \text{ dB (Typ) @ } f = 2.0 \text{ GHz}$
- High Power Gain —
 $MAG = 17 \text{ dB (Typ) @ } f = 1.0 \text{ GHz}$
 $= 11 \text{ dB (Typ) @ } f = 2.0 \text{ GHz}$
- Ion Implantation and Gold Metallization
- Metal/Ceramic Hermetic Package
- JAN, JTX, JTXV Available

***MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Free Air Temperature)**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current—Continuous	I_C	30	mA dc
Total Device Dissipation @ $T_C = 125^\circ\text{C}$ Derate Above 100°C	P_D	400 5.33	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

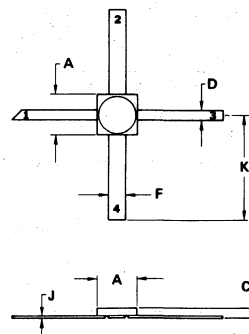
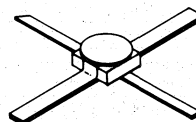
*Indicates JEDEC Registered Data

Specification and Package Options

Devices using the same die type as the 2N6603:

- MRF901 — 4 Lead Plastic Macro-T Case 302-01
- MRF902 — 100 mil Metal/Ceramic Case 303-01
- MRF904 — TO-72
- MMBR901 — MiniBloc Plastic (SOT-23) TO-236
- MRFC901 — Unencapsulated Chip

$NF = 2.0 \text{ dB @ } 1.0 \text{ GHz}$
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



STYLE 1:
 PIN 1. COLLECTOR
 2. EMITTER
 3. BASE
 4. EMITTER

NOTE:
 1. DIMENSION "K" APPLIES TO ALL LEADS.
 2. DIRECTION OF 45° CUT ON PIN 1 IS VENDOR OPTION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.29	2.67	0.090	0.105
C	0.89	1.40	0.035	0.055
D	0.41	0.61	0.016	0.024
F	0.89	1.09	0.035	0.043
J	0.08	0.15	0.003	0.006
K	4.45	5.84	0.175	0.230

CASE 303-01

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
*OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
*ON CHARACTERISTICS					
DC Current Gain ($I_C = 15\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	30	—	200	—
*DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (1) ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $0.1\text{ MHz} \leq f \leq 1.0\text{ MHz}$)	C_{cb}	0.25	—	0.75	pF
*FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($V_{CE} = 10\text{ Vdc}$, $I_C = 15\text{ mA}$, $f = 1.0\text{ GHz}$ —Figure 2)	G_{pe}	15	—	21	dB
Spot Noise Figure ($R_S = \text{Optimum}$ —Figure 2) ($V_{CE} = 10\text{ Vdc}$, $I_C = 5.0\text{ mA}$, $f = 1.0\text{ GHz}$)	NF	1.0	—	2.5	dB
Power Gain at Optimum Noise Figure ($V_{CE} = 10\text{ Vdc}$, $I_C = 5.0\text{ mA}$, $f = 1.0\text{ GHz}$)	G_{NF}	10	—	—	dB
TYPICAL 2 GHz PERFORMANCE					
Maximum Available Gain (Figure 2) (2) ($V_{CE} = 10\text{ Vdc}$, $I_C = 15\text{ mA}$, $f = 2.0\text{ GHz}$)	MAG	—	11	—	dB
Noise Figure ($R_S = \text{Optimum}$ —Figure 2) ($V_{CE} = 10\text{ Vdc}$, $I_C = 5.0\text{ mA}$, $f = 2.0\text{ GHz}$)	NF	—	2.9	—	dB

*Indicates JEDEC Registered Data.

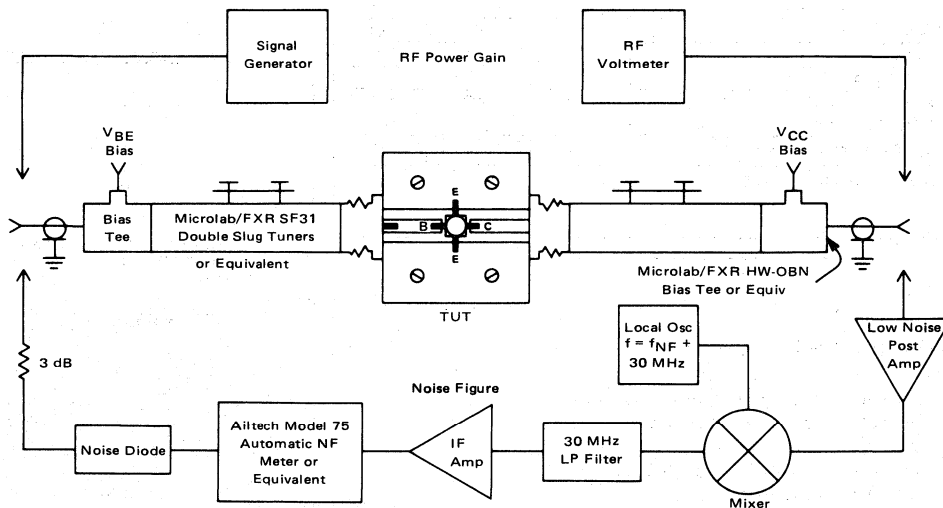
(1) C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.(2) MAG is calculated from the S-Parameters using the equation
$$\text{MAG} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$
FIGURE 1 — BLOCK DIAGRAM FOR POWER GAIN AND NOISE FIGURE

FIGURE 2 — POWER GAIN AND NOISE FIGURE
versus FREQUENCY

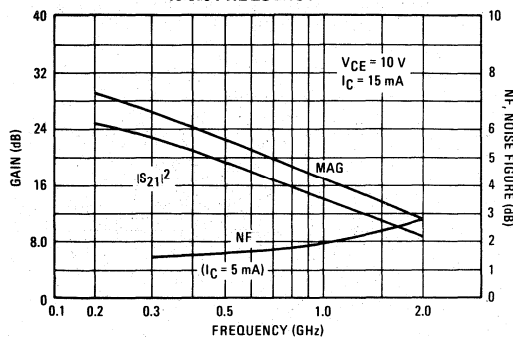


FIGURE 3 — OUTPUT CAPACITANCE versus VOLTAGE

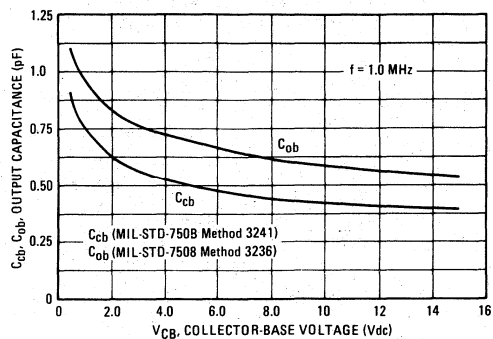


FIGURE 4 — CURRENT GAIN-BANDWIDTH PRODUCT
versus COLLECTOR CURRENT

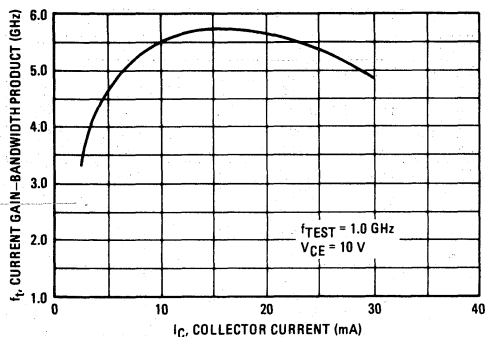


FIGURE 5 — POWER GAIN versus COLLECTOR CURRENT

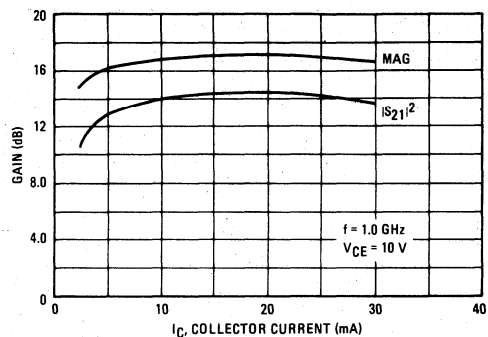
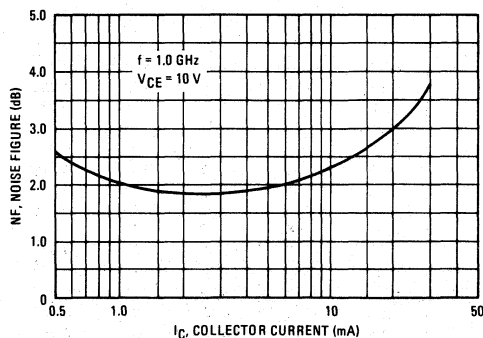


FIGURE 6 — NOISE FIGURE versus COLLECTOR CURRENT



COMMON EMITTER SCATTERING PARAMETERS

FIGURE 7 — INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY

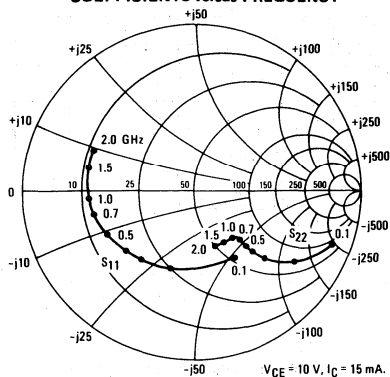
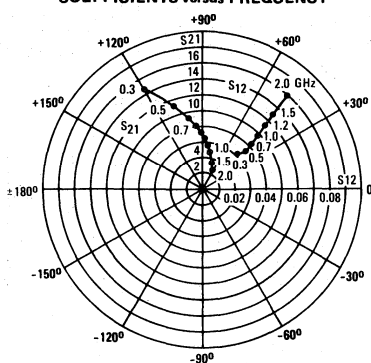
 $V_{CE} = 10 \text{ V}, I_C = 15 \text{ mA}$

FIGURE 8 — FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY

 $V_{CE} = 10 \text{ V}, I_C = 15 \text{ mA}$

S — PARAMETERS

V_{CE} (Volts)	I_C (mA)	Frequency (MHz)	S11		S21		S12		S22	
			|S11|	$\angle \phi$	|S21|	$\angle \phi$	|S12|	$\angle \phi$	|S22|	$\angle \phi$
5.0	5	100	0.69	-30	12.16	160	0.026	72	0.95	-16
		200	0.65	-61	11.03	143	0.046	59	0.84	-31
		500	0.63	-122	7.05	111	0.074	36	0.56	-54
		1000	0.64	-158	4.13	88	0.087	28	0.39	-68
		2000	0.65	170	2.14	61	0.107	29	0.33	-91
	10	100	0.52	-50	18.74	154	0.022	69	0.91	-22
		200	0.54	-92	15.53	135	0.037	53	0.74	-40
		500	0.62	-146	8.49	104	0.052	38	0.43	-62
		1000	0.65	-172	4.66	84	0.065	37	0.29	-75
		2000	0.67	162	2.38	60	0.094	42	0.26	-97
	15	100	0.42	-70	22.72	150	0.019	66	0.87	-26
		200	0.51	-113	17.72	130	0.030	50	0.68	-44
		500	0.63	-157	8.96	100	0.042	41	0.38	-64
		1000	0.66	-178	4.80	82	0.056	44	0.26	-75
		2000	0.69	159	2.43	59	0.090	48	0.24	-97
	30	100	0.39	-116	24.57	142	0.014	62	0.80	-29
		200	0.55	-145	17.17	120	0.021	49	0.58	-42
		500	0.67	-171	7.96	95	0.030	49	0.34	-49
		1000	0.69	175	4.18	78	0.047	56	0.29	-56
		2000	0.71	157	2.13	55	0.084	58	0.29	-81
10	5	100	0.71	-27	12.01	161	0.021	73	0.96	-13
		200	0.67	-55	11.10	145	0.039	60	0.87	-25
		500	0.63	-115	7.44	114	0.064	39	0.62	-44
		1000	0.64	-153	4.43	90	0.077	30	0.46	-55
		2000	0.64	172	2.27	62	0.094	31	0.39	-76
	10	100	0.55	-43	18.77	155	0.018	71	0.92	-18
		200	0.55	-83	16.00	137	0.031	54	0.78	-32
		500	0.60	-140	9.06	106	0.046	39	0.49	-48
		1000	0.63	-168	5.02	85	0.058	39	0.36	-56
		2000	0.65	164	2.55	60	0.084	43	0.33	-76
	15	100	0.46	-60	23.14	152	0.016	68	0.90	-21
		200	0.51	-103	18.39	131	0.027	52	0.72	-36
		500	0.61	-152	9.67	102	0.037	42	0.43	-49
		1000	0.64	-175	5.21	83	0.049	45	0.33	-54
		2000	0.66	161	2.61	59	0.079	51	0.31	-74
	30	100	0.39	-98	27.29	144	0.013	63	0.83	-24
		200	0.53	-135	19.38	122	0.019	50	0.63	-35
		500	0.64	-167	9.11	96	0.027	48	0.41	-39
		1000	0.66	177	4.77	79	0.042	55	0.36	-45
		2000	0.69	157	2.41	56	0.074	58	0.35	-67

2N6604

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

...designed for use in high-frequency, low-noise, small-signal, narrow and wideband amplifiers. Ideal for use in microstrip thin and thick film applications.

- Low Noise Figure — $NF = 2.7 \text{ dB (Typ) @ } f = 1.0 \text{ GHz}$
- High Power Gain — $G_U(\text{max}) = 16 \text{ dB (Typ) @ } f = 1.0 \text{ GHz}$
- High Current — Specified Performance @ $I_C = 30 \text{ mA}$
- Ion Implantation and Gold Metallization
- Metal/Ceramic Hermetic Package
- JAN, JTXV Available

***MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ Free Air Temperature)**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current—Continuous	I_C	50	mA dc
Total Device Dissipation @ $T_C = 125^\circ\text{C}$ Derate Above 75°C	P_D	500 6.66	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

*Indicates JEDEC Registered Data.

Specifications and Package Options

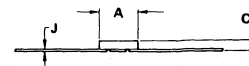
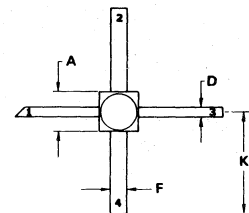
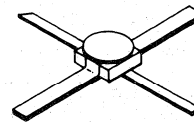
Devices using the same die type as the 2N6604:

- MRF911 — 4 Lead Plastic Macro-T Case 302-01
- MRF914 — TO-72
- MMBR930 — MiniBloc Plastic (SOT-23) TO-236
- BFR91 — 3 Lead Plastic Macro-T Case 302A-01
- BFR91 — Unencapsulated Chip

$NF = 2.7 \text{ dB @ } 1.0 \text{ GHz}$

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON



STYLE 1:
 PIN 1. COLLECTOR
 2. EMITTER
 3. BASE
 4. EMITTER

NOTE:
 1. DIMENSION "K" APPLIES TO ALL LEADS.
 2. DIRECTION OF 45° CUT ON PIN 1 IS VENDOR OPTION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.29	2.67	0.090	0.105
C	0.89	1.40	0.035	0.055
D	0.41	0.61	0.016	0.024
F	0.89	1.09	0.035	0.043
J	0.08	0.15	0.003	0.006
K	4.45	5.84	0.175	0.230

CASE 303-01

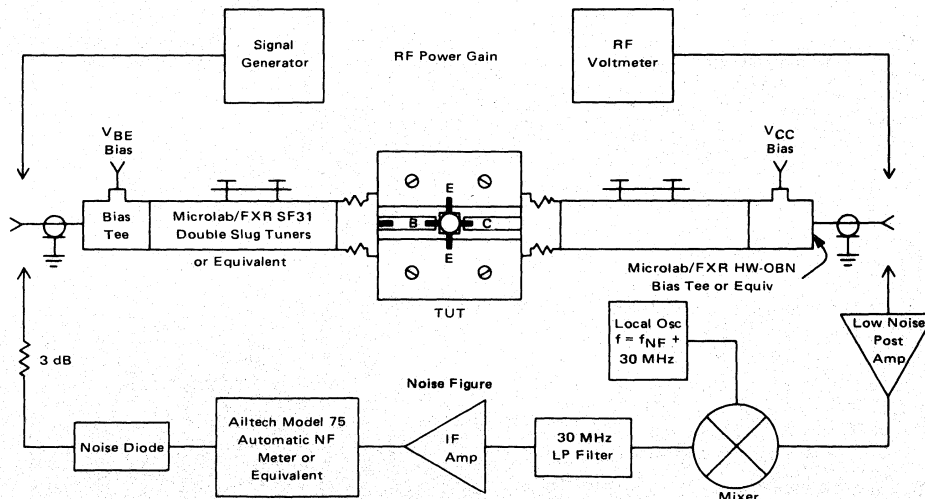
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
*OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 30\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	30	—	200	—
*DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (1) ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $0.1\text{ MHz} \leq f \leq 1.0\text{ MHz}$)	C_{cb}	0.30	—	0.80	pF
*FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 2) ($V_{CE} = 10\text{ Vdc}$, $I_C = 30\text{ mA}$, $f = 1.0\text{ GHz}$)	G_{pe}	15	—	21	dB
Spot Noise Figure ($R_S = \text{Optimum}$ — Figure 2) ($V_{CE} = 10\text{ Vdc}$, $I_C = 5.0\text{ mA}$, $f = 1.0\text{ GHz}$)	NF	1.5	—	3.0	dB
Power Gain at Optimum Noise Figure ($V_{CE} = 10\text{ Vdc}$, $I_C = 5.0\text{ mA}$, $f = 1.0\text{ GHz}$)	G_{NF}	9.0	—	—	dB
TYPICAL 2 GHz PERFORMANCE					
Maximum Unilateral Gain (Figure 2) (2) ($V_{CE} = 10\text{ Vdc}$, $I_C = 30\text{ mA}$, $f = 2.0\text{ GHz}$)	$G_U(\text{max})$	—	10	—	dB
Noise Figure ($R_S = \text{Optimum}$ — Figure 2) ($V_{CE} = 10\text{ Vdc}$, $I_C = 5.0\text{ mA}$, $f = 2.0\text{ GHz}$)	NF	—	4.3	—	dB

*Indicates JEDEC Registered Data.

(1) C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.(2) $G_U(\text{max})$ is calculated from the S-Parameters using the equation $G_U(\text{max}) = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$

FIGURE 1 — BLOCK DIAGRAM FOR POWER GAIN AND NOISE FIGURE



**FIGURE 2 – POWER GAIN AND NOISE FIGURE
versus FREQUENCY**

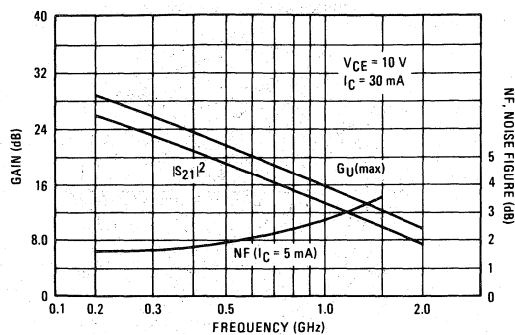
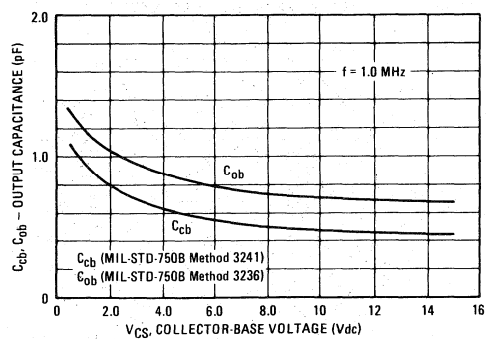


FIGURE 3 – OUTPUT CAPACITANCE versus VOLTAGE



**FIGURE 4 – CURRENT GAIN-BANDWIDTH PRODUCT
versus COLLECTOR CURRENT**

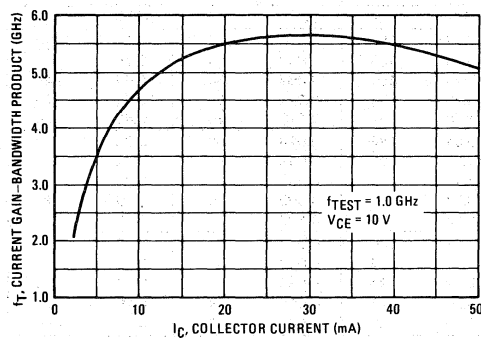


FIGURE 5 – POWER GAIN versus COLLECTOR CURRENT

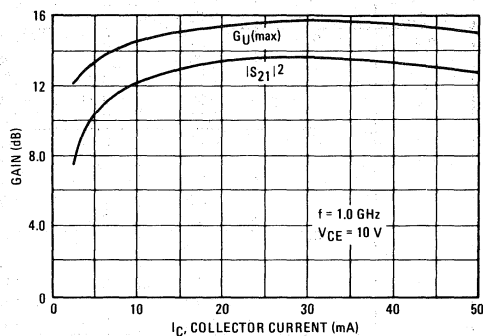
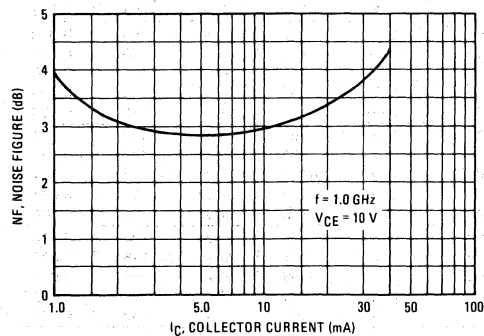


FIGURE 6 – NOISE FIGURE versus COLLECTOR CURRENT



COMMON EMITTER SCATTERING PARAMETERS

FIGURE 7 - INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY

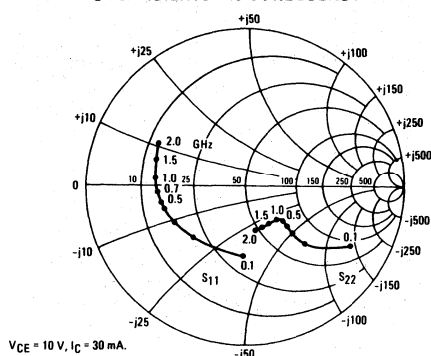
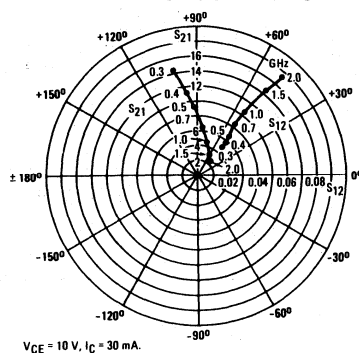


FIGURE 8 - FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY



S - PARAMETERS

V_{CE} (Volts)	I_C (mA)	Frequency (MHz)	S11		S21		S12		S22	
			|S11|	$\angle \phi$	|S21|	$\angle \phi$	|S12|	$\angle \phi$	|S22|	$\angle \phi$
5.0	5	100	0.72	-40	12.37	153	0.028	67	0.91	-18
		200	0.65	-78	10.38	133	0.048	51	0.76	-32
		500	0.61	-137	5.75	100	0.067	34	0.50	-45
		1000	0.61	-168	3.13	78	0.082	31	0.41	-54
		2000	0.63	161	1.58	47	0.112	30	0.41	-80
	10	100	0.57	-60	19.54	146	0.024	63	0.85	-27
		200	0.55	-105	14.70	125	0.038	47	0.64	-43
		500	0.59	-155	7.12	95	0.051	39	0.37	-55
		1000	0.61	-178	3.77	76	0.069	40	0.29	-62
		2000	0.64	156	1.91	50	0.106	39	0.30	-86
	30	100	0.43	-111	30.58	135	0.016	57	0.72	-39
		200	0.53	-145	19.35	114	0.022	49	0.46	-57
		500	0.62	-173	8.42	91	0.035	51	0.24	-69
		1000	0.63	172	4.36	75	0.058	54	0.18	-76
		2000	0.67	151	2.19	52	0.099	49	0.21	-99
	50	100	0.46	-134	32.34	129	0.013	57	0.64	-42
		200	0.57	-158	19.19	110	0.018	51	0.40	-56
		500	0.64	-178	8.13	89	0.031	57	0.22	-62
		1000	0.65	170	4.17	74	0.053	58	0.19	-70
		2000	0.70	150	2.10	52	0.092	54	0.22	-97
10	5	100	0.74	-36	12.34	154	0.023	69	0.93	-15
		200	0.67	-71	10.56	135	0.040	54	0.81	-25
		500	0.59	-131	6.09	102	0.058	37	0.57	-36
		1000	0.58	-164	3.32	79	0.073	33	0.50	-44
		2000	0.60	164	1.67	48	0.098	32	0.49	-69
	10	100	0.60	-52	19.75	148	0.020	65	0.87	-21
		200	0.56	-95	15.30	127	0.032	49	0.69	-33
		500	0.56	-149	7.69	97	0.044	41	0.45	-41
		1000	0.58	-174	4.07	77	0.061	42	0.39	-47
		2000	0.61	159	2.03	50	0.095	40	0.39	-70
	30	100	0.44	-94	32.03	136	0.014	59	0.75	-31
		200	0.50	-135	20.76	115	0.021	49	0.52	-41
		500	0.57	-168	9.13	91	0.032	52	0.33	-43
		1000	0.59	175	4.71	75	0.052	54	0.29	-48
		2000	0.64	154	2.34	52	0.089	49	0.30	-72
	50	100	0.44	-117	33.56	129	0.012	59	0.68	-31
		200	0.52	-150	19.94	109	0.017	50	0.47	-36
		500	0.59	-174	8.52	89	0.028	56	0.34	-35
		1000	0.61	173	4.38	75	0.049	57	0.32	-43
		2000	0.66	152	2.21	51	0.083	52	0.34	-70

The RF Line **NPN Silicon** **High Frequency Transistor**

... designed for use in high-frequency, low-noise, small-signal, narrow and wideband amplifiers. Ideal for use in microstrip thin and thick film applications.

- Low Noise Figure — $NF = 1.8 \text{ dB (Typ) @ } f = 2 \text{ GHz}$
- High Power Gain — $G_A = 12 \text{ dB (Typ) @ } f = 2 \text{ GHz}$
- Ion Implantation and Gold Metallization
- Metal/Ceramic Hermetic Package
- Capable of MIL-S-19500 and MIL-STD-750/883 Environmental and Test Requirements

***MAXIMUM RATINGS** ($T_A = 25^\circ\text{C}$ Free Air Temperature)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	20	Vdc
Collector-Base Voltage	V_{CB0}	35	Vdc
Emitter-Base Voltage	V_{EB0}	1.5	Vdc
Collector Current — Continuous	I_C	20	mAdc
Total Device Dissipation @ $T_C = 125^\circ\text{C}$ Derate Above 75°C	P_D	300 6.66	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C
Junction Temperature	T_J	200	°C
Lead Temperature (Soldering 10 seconds each lead)	—	250	°C

*Indicates JEDEC Registered Data.

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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***OFF CHARACTERISTICS**

Collector-Emitter Breakdown Voltage ($I_C = 100 \mu\text{A}$, $I_B = 0$)	$V_{(BR)CES}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($V_{CE} = 10 \text{ V}$)	I_{CEO}	—	—	500	nAdc
Collector Cutoff Current ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	100	nAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 3 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)	h_{FE}	50	100	250	—
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***DYNAMIC CHARACTERISTICS**

Collector-Base Capacitance (1) ($V_{CB} = 10 \text{ Vdc}$, $I_C = 0$, $f = 1 \text{ MHz}$)	C_{cb}	—	0.14	—	pF
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***FUNCTIONAL TEST**

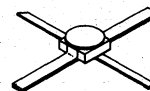
Common-Emitter Associated Gain ($V_{CE} = 10 \text{ Vdc}$, $I_C = 3 \text{ mAdc}$, $f = 2 \text{ GHz}$)	G_A	11	12	—	dB
Minimum Noise Figure ($V_{CE} = 10 \text{ Vdc}$, $I_C = 3 \text{ mAdc}$, $f = 2 \text{ GHz}$)	NF_{MIN}	—	1.8	2.2	dB

*Indicates JEDEC Registered Data.

(1) C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

2N6618

NPN SILICON
HIGH FREQUENCY
TRANSISTOR
NF = 2.2 dB MAX @ 2 GHz

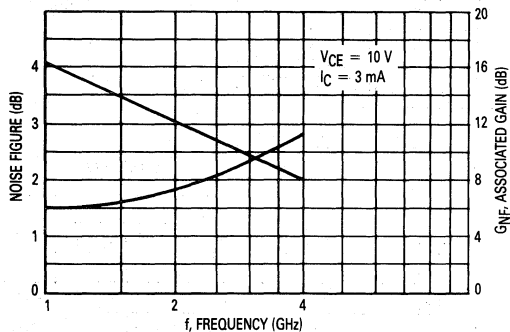
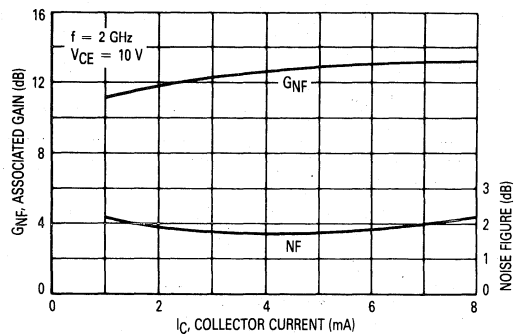
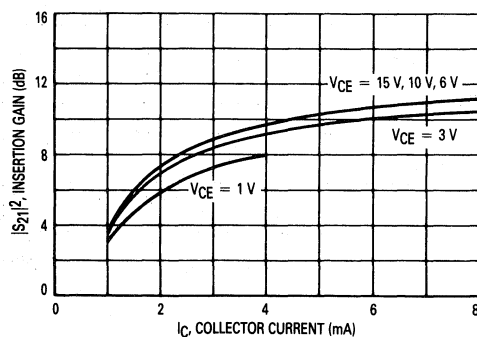


CASE 303-01

TYPICAL S-PARAMETERS

 $V_{CE} = 10\text{ V}$, $I_C = 3\text{ mA}$

f (MHz)	S ₁₁		dB	S ₂₁		dB	S ₁₂		S ₂₂	
	Mag.	Ang.		Mag.	Ang.		Mag.	Ang.	Mag.	Ang.
100	0.89	-17		9.30	168		0.01	72	0.99	-6
200	0.89	-34		9.05	156		0.01	72	0.97	-11
300	0.84	-50		8.78	146		0.02	64	0.93	-14
400	0.83	-63		8.12	138		0.03	61	0.92	-17
500	0.80	-76		7.39	129		0.03	54	0.88	-21
600	0.78	-87		6.83	123		0.04	41	0.83	-23
700	0.73	-97		6.31	117		0.04	39	0.82	-24
800	0.72	-106		6.01	110		0.04	37	0.80	-25
900	0.71	-112		5.43	105		0.04	34	0.80	-27
1000	0.70	-120		5.12	101		0.04	30	0.74	-28
1500	0.64	-143		3.60	85		0.05	27	0.70	-34
2000	0.64	-161		2.82	71		0.05	24	0.67	-37
2500	0.62	-174		2.30	56		0.05	23	0.69	-52
3000	0.62	175		1.90	44		0.06	28	0.70	-56
3500	0.61	165		1.66	34		0.06	35	0.73	-68
4000	0.61	157		1.46	24		0.06	40	0.78	-70
5000	0.62	142		1.18	8		0.08	39	0.76	-82
6000	0.60	127		0.98	-9		0.09	38	0.78	-95

Figure 1. NF_{MIN} and Associated Gain versus FrequencyFigure 2. NF_{MIN} and Associated Gain versus Collector CurrentFigure 3. $|S_{21}|^2$, Insertion Gain versus Bias at 2 GHz

The RF Line
NPN Silicon
High Frequency Transistor

2N6679

... designed for use in high-frequency, small-signal, narrow and wideband amplifiers.
Ideal for use in microstrip thin and thick film applications.

- High Output Power — $P_1 \text{ dB} = 18.5 \text{ dBm Typ @ } f = 4 \text{ GHz}$
- High Power Gain — $G_T = 10.5 \text{ dB Typ @ } f = 4 \text{ GHz}$
- High Current — Specified Performance @ $I_C = 25 \text{ mA}$
- Ion Implantation and Gold Metallization
- Metal/Ceramic Hermetic Package
- Capable of MIL-S-19500 and MIL-STD-750/883 Environmental and Test Requirements

NPN SILICON
HIGH FREQUENCY
TRANSISTOR
 $G_T = 10.5 \text{ dB TYP @ } 4 \text{ GHz}$

***MAXIMUM RATINGS** ($T_A = 25^\circ\text{C}$ Free Air Temperature)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	Vdc
Collector Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ $T_C = 125^\circ\text{C}$ Derate Above 75°C	P_D	900 6.66	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$
Lead Temperature (Soldering 10 seconds each lead)	—	250	$^\circ\text{C}$

*Indicates Ratings Same As or Greater Than JEDEC Registered Data.

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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***OFF CHARACTERISTICS**

Collector-Emitter Breakdown Voltage ($I_C = 100 \mu\text{A}$, $V_{BE} = 0$)	$V_{(BR)CES}$	30	—	—	Vdc
Collector-Emitter Leakage Current ($V_{CE} = 15 \text{ V}$)	I_{CEO}	—	—	500	nAdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	100	nAdc

***ON CHARACTERISTICS**

DC Current Gain ($I_C = 15 \text{ mAdc}$, $V_{CE} = 15 \text{ Vdc}$)	h_{FE}	50	100	220	—
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***DYNAMIC CHARACTERISTICS**

Collector-Base Capacitance (1) ($V_{CB} = 10 \text{ Vdc}$, $I_C = 0$, $f = 1 \text{ MHz}$)	C_{cb}	—	0.27	—	pF
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***FUNCTIONAL TEST**

Tuned Gain (2) ($V_{CE} = 15 \text{ Vdc}$, $I_C = 25 \text{ mAdc}$, $f = 4 \text{ GHz}$)	G_T	9	10	—	dB
Power Output at 1 dB Compression ($V_{CE} = 15 \text{ Vdc}$, $I_C = 25 \text{ mA}$, $f = 4 \text{ GHz}$)	$P_1 \text{ dB}$	—	18.5	—	dBm

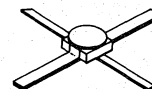
*Indicates JEDEC Registered Data.

(1) C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

$$(2) G_T = \frac{|S_{21}|^2 (1 - |I_S|^2) (1 - |I_L|^2)}{|(1 - S_{11} I_S)(1 - S_{22} I_L) - S_{12} S_{21} I_L I_S|^2}$$

I_S = Source reflection coefficient.

I_L = Load reflection coefficient.



CASE 303-01

TYPICAL S-PARAMETERS

 $V_{CE} = 15 \text{ V}, I_C = 25 \text{ mA}$

f (MHz)	S ₁₁		S ₂₁			S ₁₂		S ₂₂	
	|S ₁₁|	$\angle \phi$	S ₂₁ ²	|S ₂₁|	$\angle \phi$	|S ₁₂|	$\angle \phi$	|S ₂₂|	$\angle \phi$
100	0.60	-76	31.7	38.6	141	0.01	55	0.83	-20
500	0.67	-158	22.1	12.7	95	0.02	40	0.50	-27
1000	0.68	-178	16.4	6.6	77	0.03	53	0.46	-32
1500	0.68	170	12.9	4.4	64	0.04	54	0.47	-41
2000	0.69	162	10.6	3.4	54	0.05	54	0.47	50
2500	0.69	154	8.6	2.7	42	0.06	55	0.49	-59
3000	0.69	146	7.2	2.3	31	0.07	55	0.53	-70
3500	0.69	138	5.7	1.93	21	0.08	54	0.55	-79
4000	0.69	131	4.6	1.7	11	0.09	51	0.57	-89
4500	0.69	123	3.5	1.5	1	0.10	49	0.59	-97
5000	0.69	114	2.6	1.35	-9	0.12	44	0.62	-106
5500	0.69	106	1.8	1.23	-19	0.14	39	0.64	-113
6000	0.69	98	0.9	1.11	-28	0.15	33	0.68	-122
6500	0.69	90	0	1.01	-37	0.17	31	0.69	-130

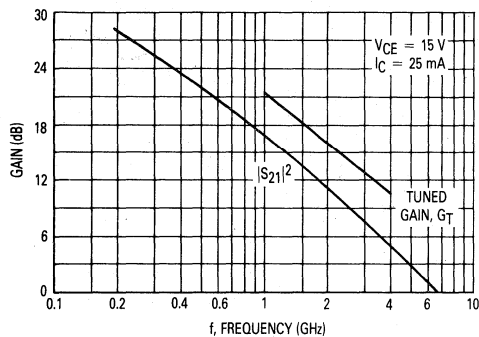
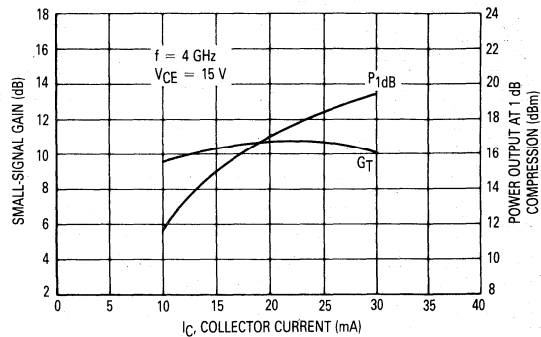
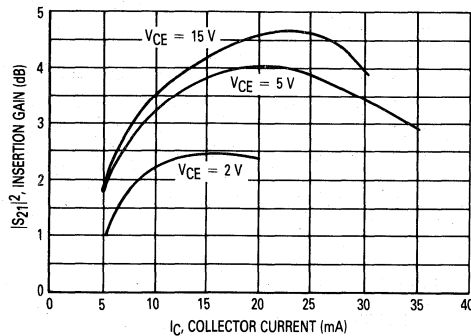
Figure 1. $|S_{21}|^2$ and Tuned Gain versus Frequency

Figure 2. Power Output at 1 dB Compression and Small-Signal Gain versus Collector Current

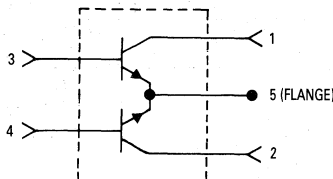
Figure 3. $|S_{21}|^2$, Insertion Gain versus Bias at 4 GHz

The RF Line

**NPN Silicon Push-Pull
RF Power Transistor**

... designed primarily for wideband large-signal output and driver amplifier stages in the 30–400 MHz frequency range.

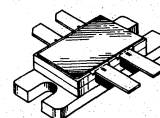
- Specified 28 Volt, 400 MHz Characteristics —
Output Power = 125 W
Typical Gain = 10 dB (Class C), 11 dB (Class AB)
Efficiency = 55% (Typ)
- Hermetic Package to Meet Stringent Environmental Requirements
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch



The 2N6985 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

2N6985

**125 WATTS, 30–400 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON**



CASE 382-01, STYLE 1

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF push-pull amplifiers.
* Indicates JEDEC Registered Data.

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5	mAdc

ON CHARACTERISTICS (NOTE 1)

DC Current Gain ($I_C = 1\text{ Adc}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS (NOTE 1)

Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	75	115	pF
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FUNCTIONAL TEST (NOTE 2 — See Figure 1)

Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 125\text{ W}$, $f = 400\text{ MHz}$)	G_{pe}	8	10	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 125\text{ W}$, $f = 400\text{ MHz}$)	η	50	55	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 125\text{ W}$, $f = 400\text{ MHz}$ VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES: 1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.

* Indicates JEDEC Registered Data.

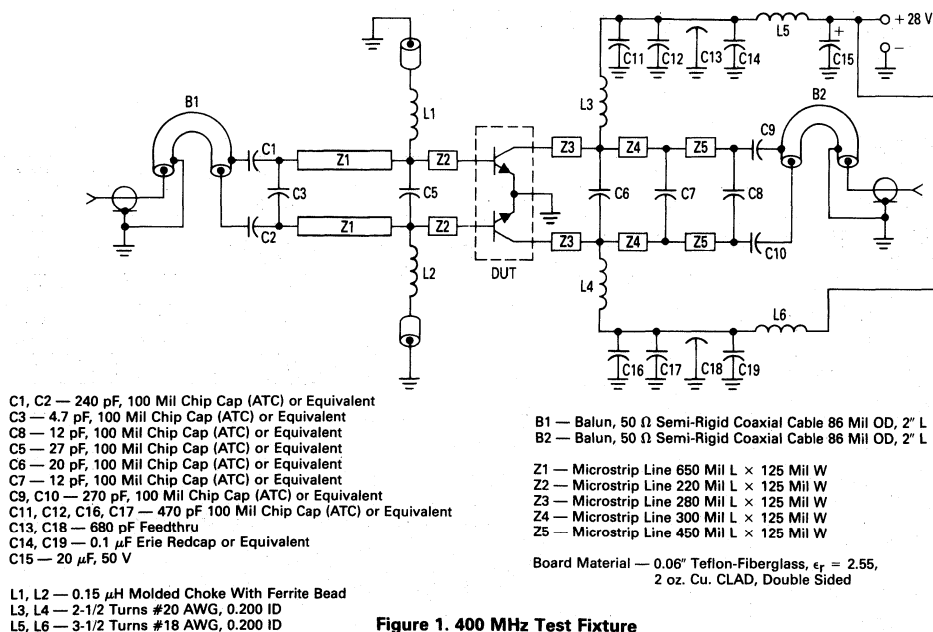
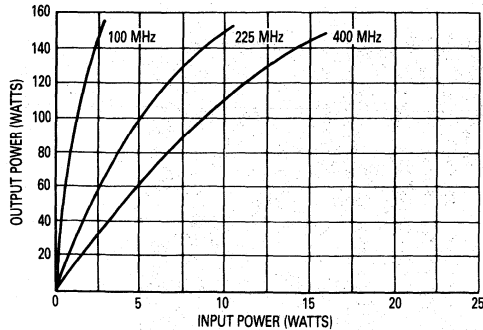
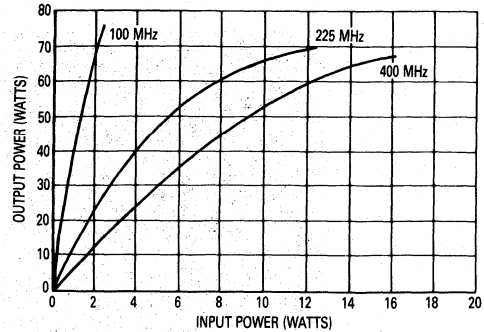


Figure 1. 400 MHz Test Fixture

OUTPUT POWER versus INPUT POWER CLASS C

Figure 2. $V_{CC} = 28 \text{ V}$ Figure 3. $V_{CC} = 13.5 \text{ V}$

OUTPUT POWER versus SUPPLY VOLTAGE CLASS C

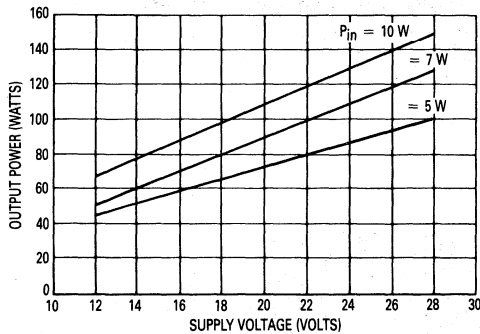
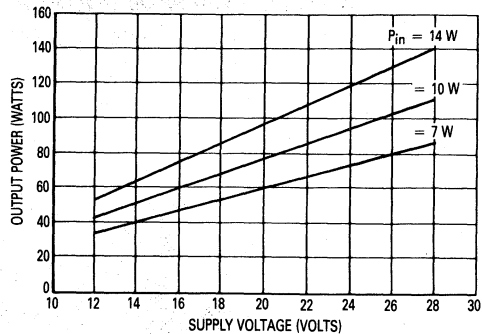
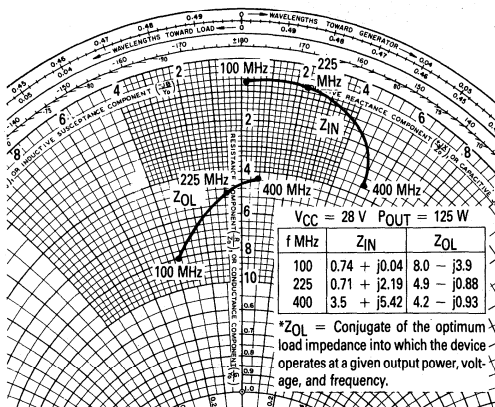
Figure 4. $f = 225 \text{ MHz}$ Figure 5. $f = 400 \text{ MHz}$ 

Figure 6. Series Equivalent Input/Output Impedance

Input and output impedances are measured from base to base and collector to collector respectively.

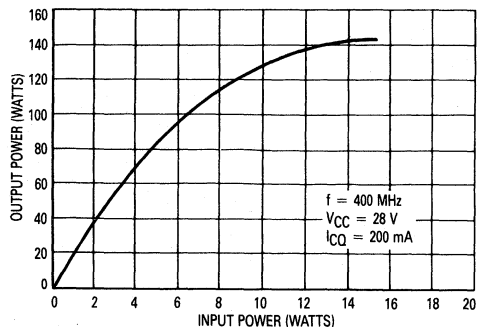
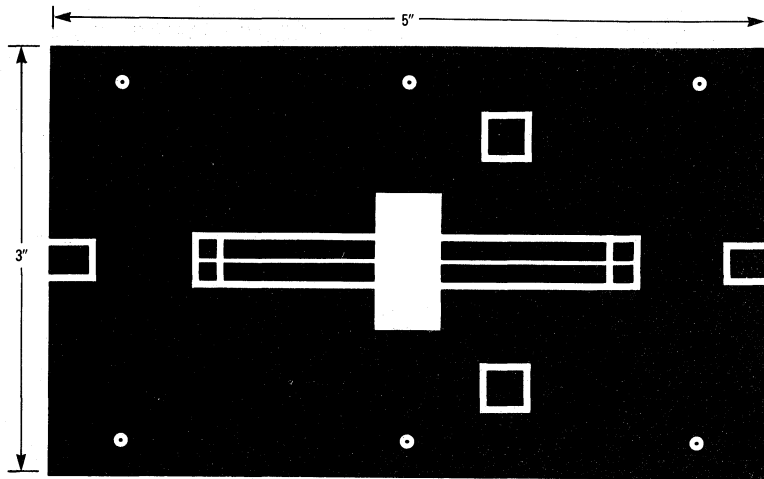


Figure 7. Class AB Output Power versus Input Power

2



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 8. Test Circuit Photomaster

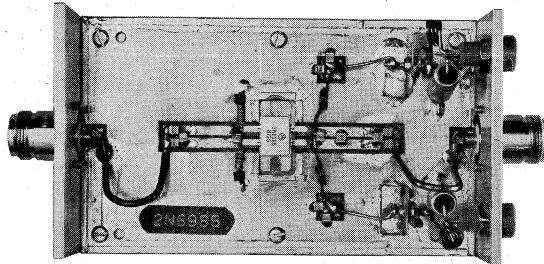


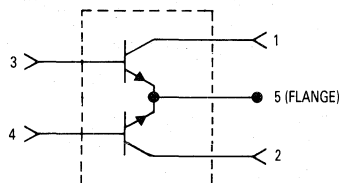
Figure 9. Test Fixture Photo

The RF Line

**NPN Silicon Push-Pull
RF Power Transistor**

... designed primarily for wideband large-signal output and driver amplifier stages in the 30–500 MHz frequency range.

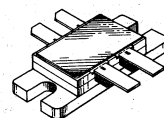
- Specified 28 Volt, 500 MHz Characteristics —
Output Power = 100 W
Typical Gain = 10.3 dB (Class AB); 9 dB (Class C)
Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch
- Hermetic Package to Meet Stringent Environmental Requirements



The 2N6986 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

2N6986

**100 WATTS, 30–500 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON**



CASE 382-01, STYLE 1

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	270 1.54	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	– 65 to + 150	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	$^\circ\text{C/W}$

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF push-pull amplifiers.

* Indicates JEDEC Registered Data.

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5	mAdc

ON CHARACTERISTICS (NOTE 1)

DC Current Gain ($I_C = 1\text{ Adc}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS (NOTE 1)

Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	75	115	pF
---	----------	---	----	-----	----

FUNCTIONAL TEST (NOTE 2 — See Figure 1)

Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 100\text{ W}$, $f = 500\text{ MHz}$)	G_{pe}	7.5	9	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 100\text{ W}$, $f = 500\text{ MHz}$)	η	50	55	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 100\text{ W}$, $f = 500\text{ MHz}$ $VSWR = 30:1$, all phase angles)	ψ	No Degradation in Output Power			

NOTES: 1. Each transistor chip measured separately.

2. Both transistor chips operating in push-pull amplifier.

* Indicates JEDEC Registered Data.

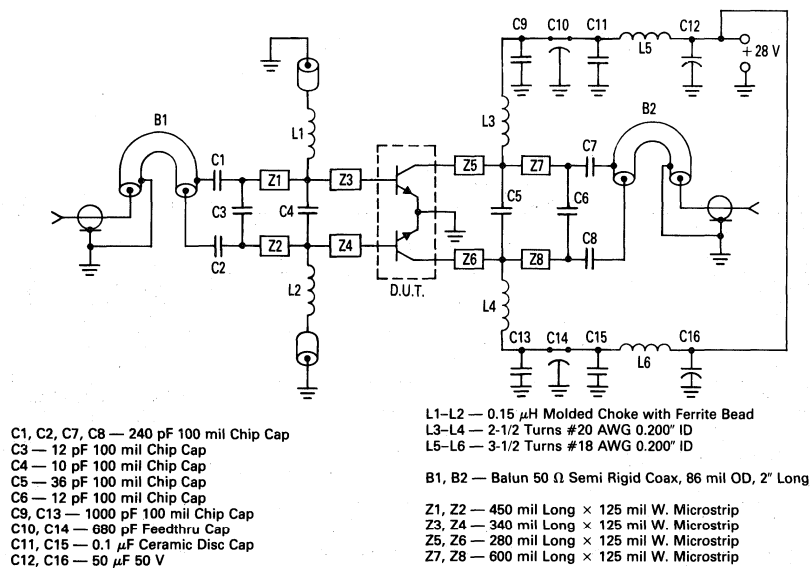
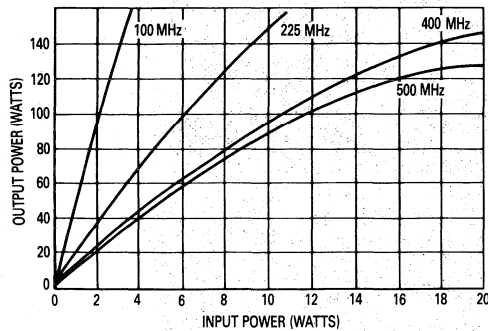
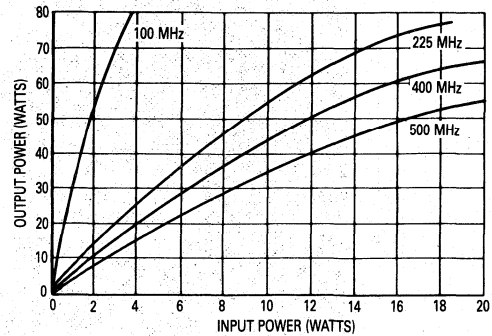


Figure 1. 500 MHz Test Fixture

OUTPUT POWER versus INPUT POWER CLASS C

Figure 2. $V_{CC} = 28 \text{ V}$ Figure 3. $V_{CC} = 13.5 \text{ V}$

OUTPUT POWER versus SUPPLY VOLTAGE CLASS C

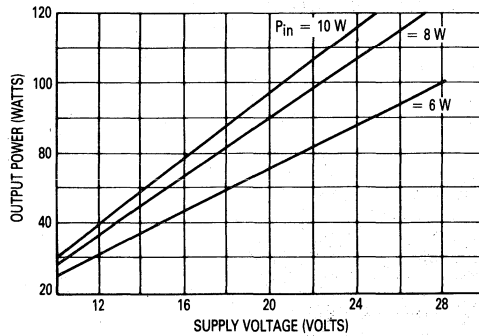
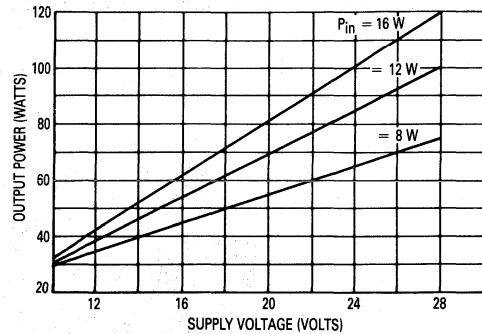
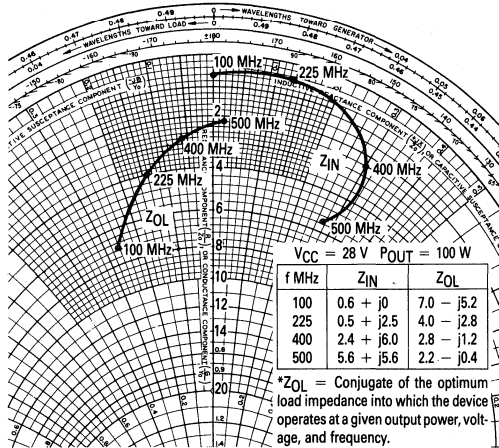
Figure 4. $f = 225 \text{ MHz}$ Figure 5. $f = 500 \text{ MHz}$ 

Figure 6. Series Equivalent Input/Output Impedance

Input and output impedances are measured from base to base and collector to collector respectively.

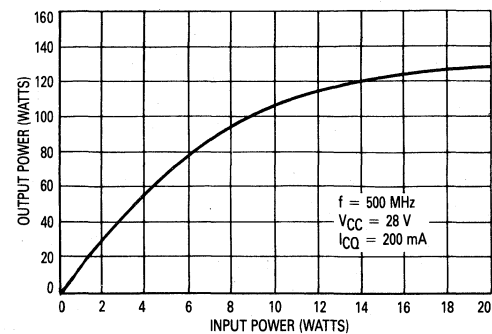
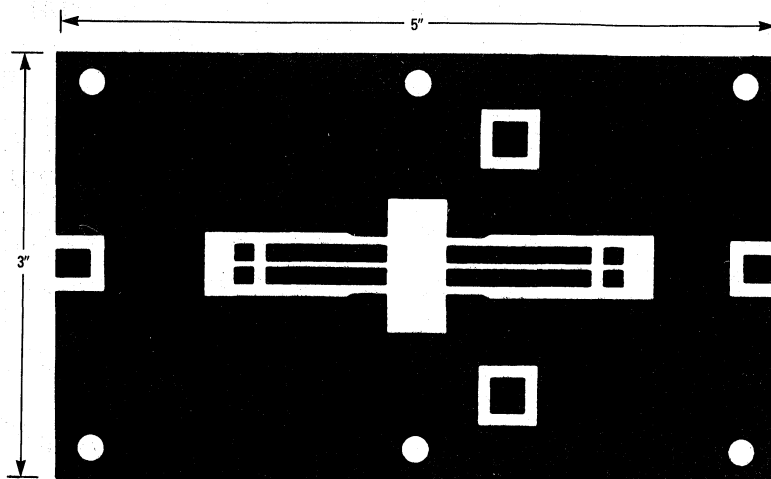


Figure 7. Class AB Output Power versus Input Power

2



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 8. Test Circuit Photomaster

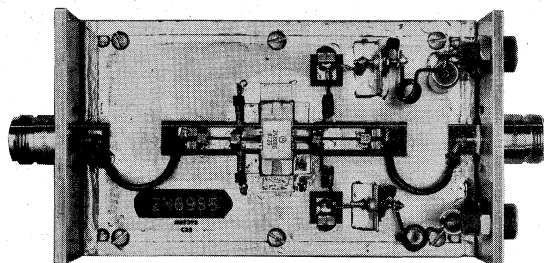


Figure 9. Test Fixture Photo

BFR90

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

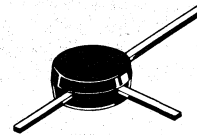
...designed primarily for use in high-gain, low-noise, small-signal amplifiers. Also used in applications requiring fast switching times.

- High Current-Gain — Bandwidth Product —
 $f_T = 5.0 \text{ GHz (Typ) @ } I_C = 14 \text{ mA}$
- Low Noise Figure —
 $NF = 2.4 \text{ dB (Typ) @ } f = 0.5 \text{ GHz}$
 $= 3.0 \text{ dB (Typ) @ } f = 1.0 \text{ GHz}$
- High Power Gain —
 $G_{max} = 18 \text{ dB (Typ) @ } f = 0.5 \text{ GHz}$
 $= 12 \text{ dB (Typ) @ } f = 1.0 \text{ GHz}$

$f_T = 5.0 \text{ GHz @ } 14 \text{ mA}$

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON



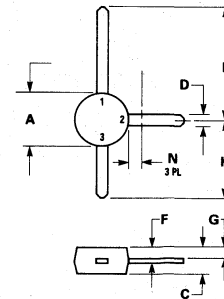
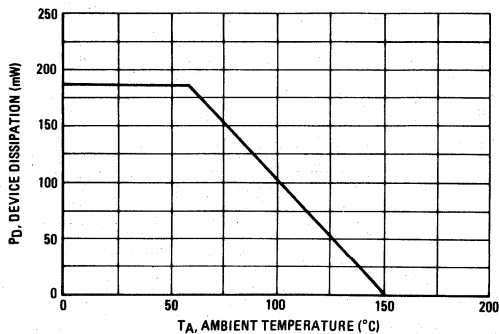
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	30	mA dc
Total Device Dissipation @ $T_A = 60^\circ\text{C}$	P_D	180	mW
Derate Above 60°C		2.0	mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to $+150$	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	500	$^\circ\text{C/W}$

FIGURE 1 — POWER DERATING



STYLE 2:
PIN 1: COLLECTOR
2: EMITTER
3: BASE

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317A-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	50	nAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 14\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	25	—	250	—
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DYNAMIC CHARACTERISTICS

Current-Gain Bandwidth Product ($I_C = 14\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$)	f_T	—	5.0	—	GHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{cb}	—	0.5	1.0	pF

FUNCTIONAL TESTS

Noise Figure ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$) ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ GHz}$)	NF	— —	2.4 3.0	— —	dB
Power Gain at Optimum Noise Figure ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$) ($I_C = 2.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ GHz}$)	G_{NF}	— —	15 10	— —	dB
Maximum Available Power Gain (1) ($I_C = 14\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$) ($I_C = 14\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ GHz}$)	G_{max}	— —	18 12	— —	dB

$$(1) G_{max} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

FIGURE 2 – POWER GAIN AND NOISE FIGURE versus FREQUENCY

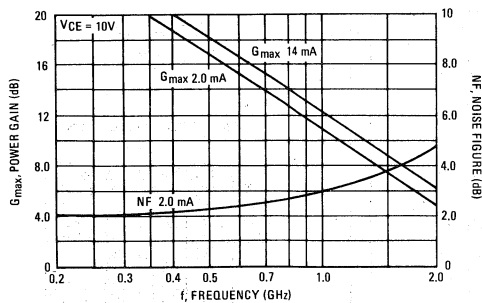


FIGURE 3 – POWER GAIN AND NOISE FIGURE versus COLLECTOR CURRENT

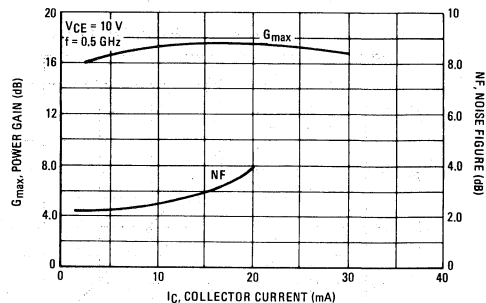


FIGURE 4 – S_{11} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V _{CE} (Volts)	I _C (mA)	S ₁₁	$\angle\phi$	S ₁₁	$\angle\phi$	S ₁₁	$\angle\phi$	S ₁₁	$\angle\phi$	S ₁₁	$\angle\phi$
5.0	2.0	0.77	-45	0.48	-90	0.33	-125	0.27	-160	0.28	170
	5.0	0.52	-60	0.25	-110	0.18	-150	0.18	170	0.21	145
	10	0.33	-75	0.15	-125	0.13	-175	0.15	150	0.20	130
	20	0.20	-95	0.12	-155	0.14	165	0.17	145	0.22	130
	30	0.17	-116	0.14	-170	0.17	160	0.21	145	0.26	130
10	2.0	0.79	-40	0.50	-80	0.33	-115	0.26	-150	0.25	175
	5.0	0.56	-55	0.27	-95	0.16	-135	0.13	-175	0.17	150
	10	0.39	-65	0.16	-105	0.10	-150	0.10	165	0.15	140
	20	0.25	-75	0.10	-120	0.09	-175	0.12	150	0.18	130
	30	0.25	-75	0.10	-120	0.09	-175	0.12	150	0.18	130

FIGURE 5 – S_{22} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V _{CE} (Volts)	I _C (mA)	S ₂₂	$\angle\phi$	S ₂₂	$\angle\phi$	S ₂₂	$\angle\phi$	S ₂₂	$\angle\phi$	S ₂₂	$\angle\phi$
5.0	2.0	0.89	-20	0.69	-30	0.61	-35	0.55	-35	0.52	-45
	5.0	0.75	-25	0.55	-30	0.50	-30	0.47	-30	0.43	-40
	10	0.64	-25	0.49	-25	0.45	-25	0.43	-30	0.40	-35
	20	0.57	-25	0.47	-20	0.44	-25	0.43	-25	0.40	-35
	30	0.55	-20	0.47	-20	0.46	-20	0.44	-25	0.42	-35
10	2.0	0.91	-15	0.74	-25	0.66	-30	0.62	-35	0.59	-40
	5.0	0.79	-20	0.61	-25	0.56	-25	0.54	-30	0.51	-35
	10	0.70	-20	0.56	-20	0.53	-25	0.51	-25	0.48	-35
	20	0.63	-20	0.54	-25	0.53	-20	0.51	-25	0.49	-35
	30	0.63	-15	0.56	-15	0.55	-20	0.54	-25	0.52	-35

FIGURE 6 – S_{21} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V _{CE} (Volts)	I _C (mA)	S ₂₁	$\angle\phi$	S ₂₁	$\angle\phi$	S ₂₁	$\angle\phi$	S ₂₁	$\angle\phi$	S ₂₁	$\angle\phi$
5.0	2.0	5.76	140	3.81	105	2.73	90	2.20	75	1.70	60
	5.0	9.92	125	5.24	95	3.50	80	2.80	70	2.10	60
	10	12.33	115	5.82	90	3.79	75	2.90	65	2.20	55
	20	13.62	105	6.00	85	3.88	75	2.95	65	2.25	55
	30	13.41	105	5.80	80	3.74	75	2.85	65	2.15	55
10	2.0	5.77	145	3.88	110	2.80	90	2.25	75	1.75	60
	5.0	10.05	130	5.42	95	3.60	80	2.85	70	2.10	60
	10	12.56	115	6.00	90	3.90	80	3.05	70	2.25	55
	20	13.77	110	6.13	85	3.92	75	3.05	65	2.20	55
	30	13.23	105	5.79	85	3.70	75	2.85	65	2.15	55

FIGURE 7 – S_{12} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V _{CE} (Volts)	I _C (mA)	S ₁₂	$\angle\phi$	S ₁₂	$\angle\phi$	S ₁₂	$\angle\phi$	S ₁₂	$\angle\phi$	S ₁₂	$\angle\phi$
5.0	2.0	0.06	65	0.10	55	0.12	55	0.14	55	0.17	60
	5.0	0.05	65	0.08	65	0.12	65	0.15	65	0.19	65
	10	0.04	65	0.08	70	0.12	70	0.15	70	0.20	65
	20	0.04	75	0.08	75	0.12	75	0.15	70	0.20	70
	30	0.03	75	0.07	75	0.11	75	0.15	75	0.19	70
10	2.0	0.05	70	0.03	55	0.11	55	0.12	55	0.15	60
	5.0	0.04	65	0.07	65	0.10	65	0.13	65	0.17	70
	10	0.04	65	0.07	70	0.10	70	0.13	70	0.17	70
	20	0.03	70	0.07	75	0.10	75	0.13	75	0.17	70
	30	0.03	75	0.06	75	0.10	75	0.13	75	0.17	70

BFR91

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

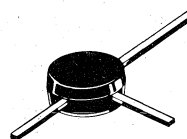
... designed primarily for use in high-gain, low-noise, small-signal amplifiers. Also used in applications requiring fast switching times.

- High Current-Gain – Bandwidth Product –
 $f_T = 5.0 \text{ GHz (Typ) @ } I_C = 30 \text{ mA}$
- Low Noise Figure –
 $NF = 1.9 \text{ dB (Typ) @ } f = 0.5 \text{ GHz}$
- High Power Gain –
 $G_{\text{max}} = 16 \text{ dB (Typ) @ } f = 0.5 \text{ GHz}$

$f_T = 5.0 \text{ GHz @ } 30 \text{ mA}$

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON



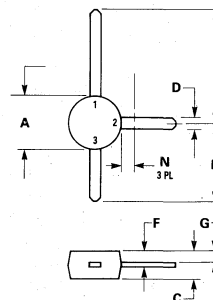
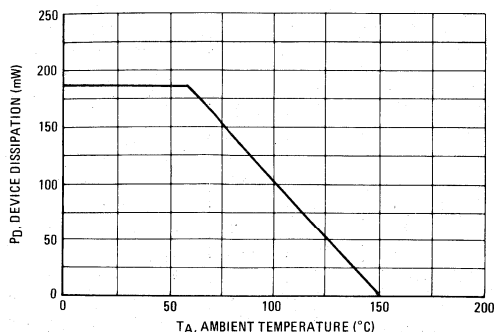
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current – Continuous	I_C	35	mA _{dc}
Total Device Dissipation @ $T_A = 60^\circ\text{C}$ Derate Above 60°C	P_D	180	mW
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	500	$^\circ\text{C/W}$

FIGURE 1 – POWER DERATING



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317A-01

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mA _{dc} , I _B = 0)	V _{(BR)CEO}	12	—	—	V _{dc}
Collector-Base Breakdown Voltage (I _C = 0.1 mA _{dc} , I _E = 0)	V _{(BR)CBO}	15	—	—	V _{dc}
Emitter-Base Breakdown Voltage (I _E = 0.1 mA _{dc} , I _C = 0)	V _{(BR)EBO}	2.0	—	—	V _{dc}
Collector Cutoff Current (V _{CB} = 5.0 V _{dc} , I _E = 0)	I _{CBO}	—	—	50	nA _{dc}
ON CHARACTERISTICS					
DC Current Gain (I _C = 30 mA _{dc} , V _{CE} = 5.0 V _{dc})	h _{FE}	25	—	250	—
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I _C = 30 mA _{dc} , V _{CE} = 5.0 V _{dc} , f = 0.5 GHz)	f _T	—	5.0	—	GHz
Collector-Base Capacitance (V _{CB} = 10 V _{dc} , I _E = 0, f = 1.0 MHz)	C _{cb}	—	0.7	1.0	pF
FUNCTIONAL TESTS					
Noise Figure (I _C = 2.0 mA _{dc} , V _{CE} = 5.0 V _{dc} , f = 0.5 GHz) (I _C = 2.0 mA _{dc} , V _{CE} = 5.0 V _{dc} , f = 1.0 GHz)	NF	— —	1.9 2.5	— —	dB
Power Gain at Optimum Noise Figure (I _C = 2.0 mA _{dc} , V _{CE} = 5.0 V _{dc} , f = 0.5 GHz) (I _C = 2.0 mA _{dc} , V _{CE} = 5.0 V _{dc} , f = 1.0 GHz)	G _{NF}	— —	11 8.0	— —	dB
Maximum Available Power Gain (1) (I _C = 30 mA _{dc} , V _{CE} = 5.0 V _{dc} , f = 0.5 GHz) (I _C = 30 mA _{dc} , V _{CE} = 5.0 V _{dc} , f = 1.0 GHz)	G _{max}	— —	16 10	— —	dB

(1) $G_{\max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 2 - POWER GAIN AND NOISE FIGURE versus FREQUENCY

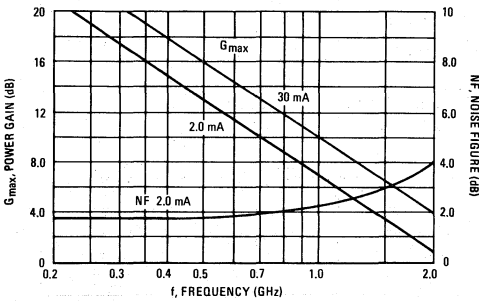


FIGURE 3 - POWER GAIN AND NOISE FIGURE versus COLLECTOR CURRENT

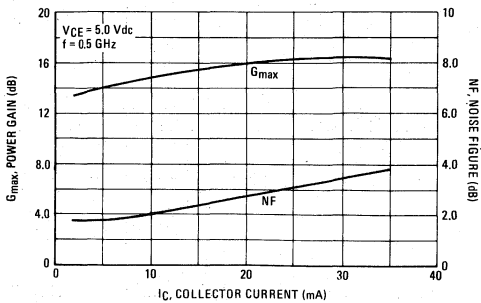


FIGURE 4 – S₁₁ PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V _{CE} (Volts)	I _C (mA)	S ₁₁	∠φ	S ₁₁	∠φ	S ₁₁	∠φ	S ₁₁	∠φ	S ₁₁	∠φ
5.0	2.0	0.72	-65	0.51	-125	0.46	-165	0.47	170	0.51	145
	5.0	0.49	-90	0.35	-150	0.34	175	0.36	155	0.41	135
	10	0.34	-110	0.28	-165	0.29	165	0.32	145	0.36	130
	20	0.26	-130	0.24	180	0.27	155	0.30	140	0.34	125
	30	0.24	-145	0.24	175	0.27	155	0.30	140	0.34	125
10	2.0	0.74	-60	0.51	-120	0.45	-160	0.45	170	0.49	150
	5.0	0.52	-80	0.33	-140	0.31	-175	0.32	160	0.37	145
	10	0.36	-95	0.24	-155	0.24	170	0.27	155	0.31	140
	20	0.25	-115	0.19	-170	0.21	160	0.24	145	0.29	130
	30	0.22	-120	0.19	-175	0.21	160	0.25	145	0.20	130

FIGURE 5 – S₂₂ PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V _{CE} (Volts)	I _C (mA)	S ₂₂	∠φ	S ₂₂	∠φ	S ₂₂	∠φ	S ₂₂	∠φ	S ₂₂	∠φ
5.0	2.0	0.83	-25	0.62	-35	0.55	-40	0.51	-45	0.49	-60
	5.0	0.66	-30	0.45	-35	0.40	-40	0.37	-40	0.34	-50
	10	0.52	-35	0.36	-35	0.32	-35	0.30	-35	0.27	-50
	20	0.42	-35	0.30	-30	0.27	-30	0.26	-30	0.22	-45
	30	0.38	-35	0.28	-25	0.26	-30	0.25	-30	0.21	-40
10	2.0	0.86	-20	0.67	-30	0.62	-35	0.58	-40	0.56	-50
	5.0	0.71	-25	0.53	-30	0.48	-30	0.45	-35	0.43	-45
	10	0.59	-30	0.45	-25	0.41	-30	0.40	-30	0.37	-40
	20	0.50	-25	0.40	-25	0.38	-25	0.37	-30	0.34	-40
	30	0.47	-25	0.40	-20	0.38	-25	0.37	-30	0.34	-35

FIGURE 6 – S₂₁ PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V _{CE} (Volts)	I _C (mA)	S ₂₁	∠φ	S ₂₁	∠φ	S ₂₁	∠φ	S ₂₁	∠φ	S ₂₁	∠φ
5.0	2.0	5.25	130	3.06	95	2.10	75	1.70	65	1.20	50
	5.0	8.72	120	4.34	90	2.84	75	2.30	65	1.60	50
	10	10.85	110	4.92	85	3.22	70	2.60	65	1.80	50
	20	12.13	105	5.34	80	3.44	70	2.75	60	1.90	50
	30	12.50	100	5.42	80	3.47	70	2.75	60	1.90	50
10	2.0	5.36	135	3.20	95	2.20	80	1.85	65	1.30	50
	5.0	9.05	120	4.55	90	3.00	75	2.45	65	1.65	50
	10	11.37	110	5.22	85	3.40	75	2.65	65	1.85	50
	20	12.83	105	5.64	80	3.63	70	2.75	60	2.00	50
	30	13.10	100	5.62	80	3.63	70	2.75	60	2.00	50

FIGURE 7 – S₁₂ PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V _{CE} (Volts)	I _C (mA)	S ₁₂	∠φ	S ₁₂	∠φ	S ₁₂	∠φ	S ₁₂	∠φ	S ₁₂	∠φ
5.0	2.0	0.08	55	0.11	45	0.12	50	0.14	55	0.17	65
	5.0	0.06	55	0.09	60	0.13	65	0.17	65	0.22	65
	10	0.05	60	0.09	65	0.14	70	0.19	65	0.24	65
	20	0.05	70	0.07	70	0.15	70	0.19	70	0.25	65
	30	0.04	75	0.10	75	0.15	70	0.19	70	0.25	65
10	2.0	0.06	60	0.09	45	0.10	50	0.12	60	0.15	70
	5.0	0.05	60	0.08	60	0.11	65	0.15	65	0.19	70
	10	0.05	65	0.08	65	0.12	70	0.16	70	0.21	70
	20	0.04	70	0.08	70	0.13	70	0.17	70	0.22	70
	30	0.04	70	0.08	75	0.13	70	0.17	70	0.22	70

The RF Line
NPN Silicon
High Frequency Transistors

... designed primarily for use in high-gain, low-noise, small-signal UHF and microwave amplifiers constructed with thick and thin-film circuits using surface mount components.

BFR92
BFR92A

RF TRANSISTORS
NPN SILICON

2

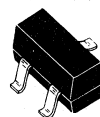
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	25	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.



CASE 318-05, STYLE 6
SOT-23

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (1) ($I_C = 10\text{ mA}$)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 10\text{ V}$)	BFR92 BFR92A I_{CBO}	— —	50 60	nA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 500\text{ }\mu\text{A}$, $V_{CE} = 10\text{ V}$) ($I_C = 14\text{ mA}$, $V_{CE} = 10\text{ V}$)	BFR92 BFR92A h_{FE}	25 40	— —	—
Collector-Emitter Saturation Voltage (1) ($I_C = 25\text{ mA}$, $I_B = 5.0\text{ mA}$)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (1) ($I_C = 25\text{ mA}$, $I_B = 5.0\text{ mA}$)	$V_{BE(sat)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 14\text{ mA}$, $V_{CE} = 10\text{ V}$, $f = 500\text{ MHz}$)	f_T	3.0	—	GHz
Noise Figure ($V_{CE} = 1.5\text{ V}$, $I_C = 3.0\text{ mA}$, $R_S = 50\text{ }\Omega$, $f = 500\text{ MHz}$)	NF	—	3.0 (Typ)	dB
Capacitance-Collector to Base ($V_{CB} = 10\text{ Vdc}$, $f = 1.0\text{ MHz}$)	C_{cb}	—	0.7 (Typ)	pF

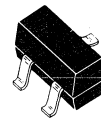
(1) Pulse Width $\leq 300\text{ }\mu\text{s}$, Duty Cycle $\leq 2.0\%$.

The RF Line
NPN Silicon
High Frequency Transistors

... designed primarily for use in high-gain, low-noise, small-signal UHF and microwave amplifiers constructed with thick and thin-film circuits using surface mount components.

BFR93
BFR93A

RF TRANSISTORS
NPN SILICON



CASE 318-05, STYLE 6
SOT-23

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	35	mA _{dc}
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (1) ($I_C = 10\text{ mA}$)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ }\mu\text{A}$)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 10\text{ V}$)	I_{CEO}	—	50	nA
Collector Cutoff Current ($V_{CB} = 10\text{ V}$)	I_{CBO}	—	50	nA

ON CHARACTERISTICS

DC Current Gain (1) ($I_C = 30\text{ mA}, V_{CE} = 5.0\text{ V}$) ($I_C = 30\text{ mA}, V_{CE} = 5.0\text{ V}$)	h_{FE} BFR93A BFR93	40 25	— —	—
Collector-Emitter Saturation Voltage (1) ($I_C = 35\text{ mA}, I_B = 7.0\text{ mA}$)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (1) ($I_C = 35\text{ mA}, I_B = 7.0\text{ mA}$)	$V_{BE(sat)}$	—	1.2	Vdc

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 30\text{ mA}, V_{CE} = 5.0\text{ V}, f = 500\text{ MHz}$)	f_T	3.0	—	GHz
Noise Figure ($V_{CE} = 5.0\text{ V}, I_C = 2.0\text{ mA}, R_S = 50\text{ }\Omega, f = 30\text{ MHz}$)	NF	—	3.0	dB

(1) Pulse Width $\leq 300\text{ }\mu\text{s}$, Duty Cycle $\leq 2.0\%$.

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS

The BFR96 series transistors use the same state-of-the-art micro-wave transistor chip which features fine-line geometry, ion-implanted arsenic emitters and gold top metalization. These transistors are intended for low-to-medium power amplifiers requiring high gain, low noise figure, and low intermodulation distortion. The BFR96 and MRF961 are particularly suitable for broadband MATV/CATV amplifiers. The MRF962 uses a hermetic stripline, ceramic package and is intended for high reliability applications up to 2 GHz. The MRF965 makes an excellent VHF/UHF Class C driver amplifier for several hundred milliwatts power output.




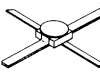

BFR96
BFRC96
MRF961
MRF962
MRF965

2

$f_T = 4.5 \text{ GHz @ } 50 \text{ mA}$

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON

		BFR96	BFR96	MRF961	MRF962	MRF965	
							
MAXIMUM RATINGS		Chip	Case 317A-01 Style 2	Case 317-01 Style 2	Case 303-01 Style 1	Case 26-03 Style 1	
Ratings	Symbol	Values					Unit
Collector-Emitter Voltage	V_{CEO}	15	15	15	15	15	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	3.0	3.0	3.0	3.0	Vdc
Collector Current — Continuous	I_C	100	100	100	100	100	mAdc
Total Device Dissipation @ $T_C = 100^\circ\text{C}$ ⁽¹⁾ Derate above $T_C = 100^\circ\text{C}$	P_D	0.75 $T_J = 200^\circ\text{C}$ max	0.5 10	0.5 10	0.75 7.5	0.75 7.5	Watts mW/ $^\circ\text{C}$
Storage Temperature	T_{stg}	-65 to +200	-65 to +150	-65 to +150	-65 to +200	-65 to +200	$^\circ\text{C}$

NOTE 1. Case temperature measured on collector lead immediately adjacent to body of package.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$, $I_E = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{A}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	30	—	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$)	f_T	—	4.5	—	GHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, Emitter Guarded)	C_{cb}	—	1.2	1.5	pF
		—	1.6	2.0	
FUNCTIONAL TESTS					
Noise Figure ($I_C = 10\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$)	NF	—	2.0	—	dB
Maximum Unilateral Gain/Insertion Gain ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$)	$G_{U(max)}/|S_{21}|^2$	—/12 —/13.5 —/15	14.5/13 17/15 20.5/16.5	— — —	dB

NOTE 1. $G_{U(max)} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$

FIGURE 1 — MAXIMUM UNILATERAL GAIN versus FREQUENCY

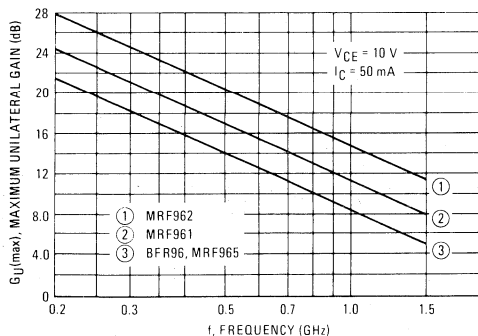
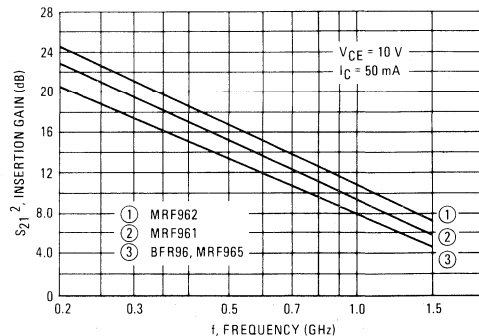
FIGURE 2 — $|S_{21}|^2$ versus FREQUENCY

FIGURE 3 — MAXIMUM UNILATERAL GAIN versus COLLECTOR CURRENT

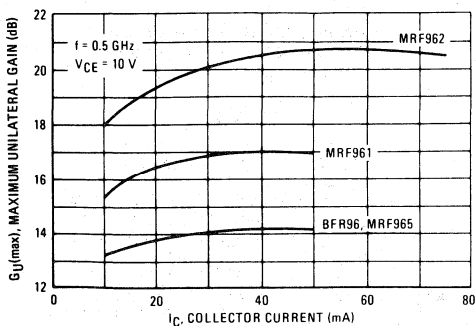


FIGURE 4 — GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

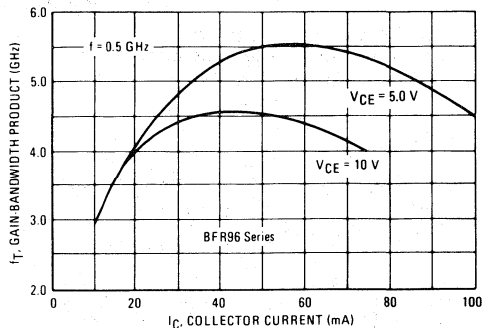


FIGURE 5 — NOISE FIGURE versus FREQUENCY

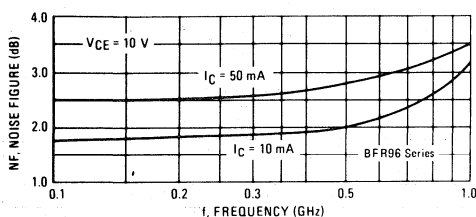


FIGURE 6 — NOISE FIGURE versus COLLECTOR CURRENT

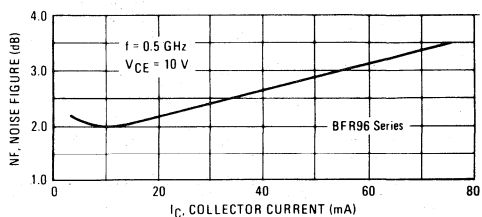


FIGURE 7 — COLLECTOR-BASE CAPACITANCE versus COLLECTOR-BASE VOLTAGE

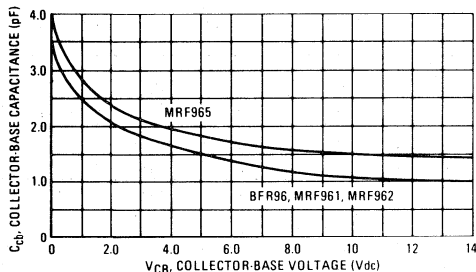


FIGURE 8 — OUTPUT POWER AND EFFICIENCY versus INPUT POWER (MRF965)

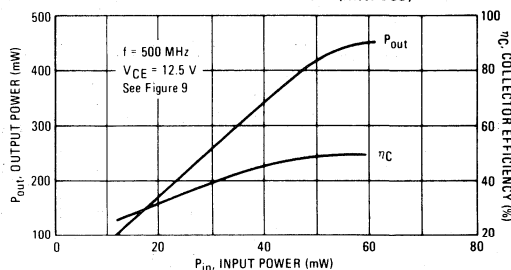
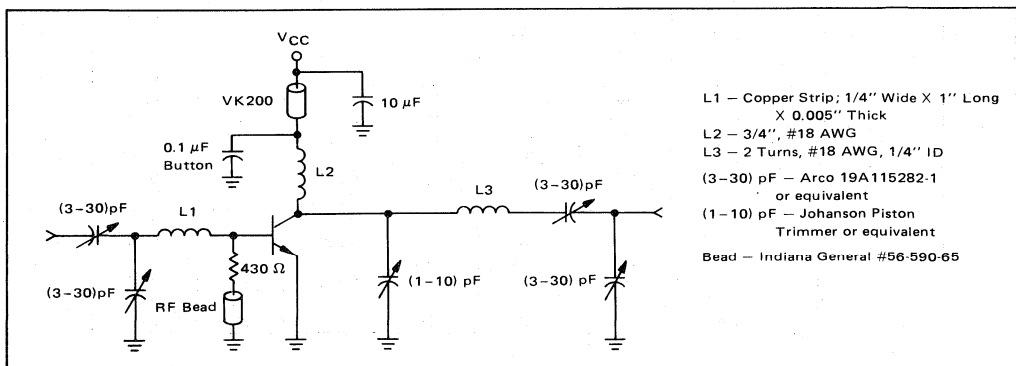
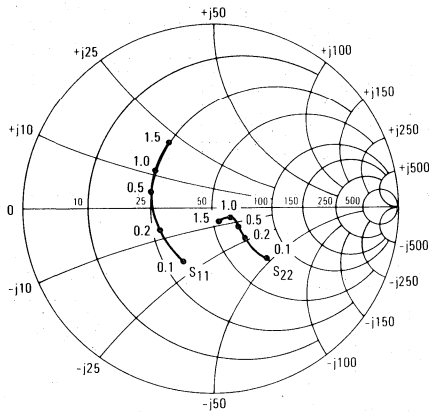


FIGURE 9 — MRF965 CLASS C AMPLIFIER @ 500 MHz, 400 mW

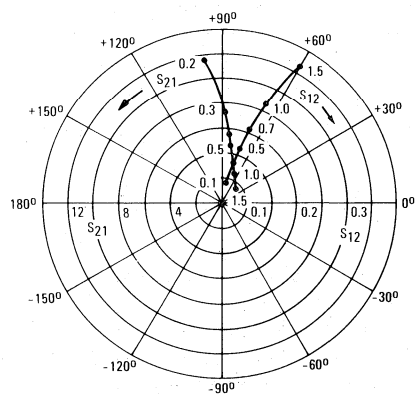


BFR96 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$)



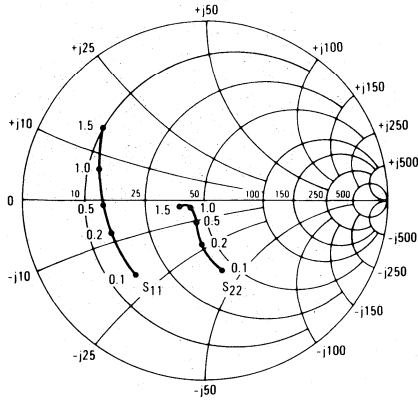
FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$)



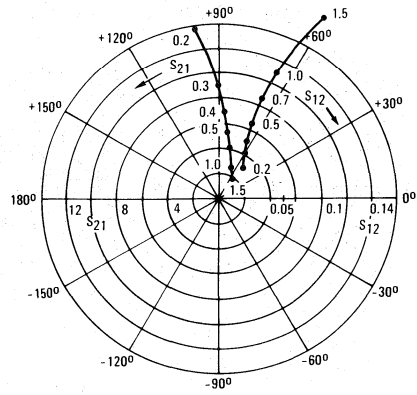
V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
5.0	10	100	0.51	-95	15.04	121	0.047	54	0.58	-48
		300	0.43	-163	5.87	92	0.082	58	0.26	-63
		500	0.46	174	3.61	79	0.120	63	0.19	-63
		700	0.48	162	2.65	68	0.161	63	0.15	-64
		1000	0.48	146	1.92	57	0.220	63	0.12	-79
		1500	0.54	121	1.40	43	0.320	58	0.13	-118
	25	100	0.39	-122	19.41	112	0.037	60	0.42	-68
		300	0.39	-176	6.81	89	0.079	68	0.16	-94
		500	0.42	166	4.11	78	0.129	70	0.10	-103
		700	0.44	156	3.05	69	0.176	68	0.06	-119
		1000	0.44	142	2.20	59	0.244	64	0.06	-159
		1500	0.49	118	1.62	45	0.348	57	0.10	177
	50	100	0.35	-140	21.10	106	0.032	64	0.33	-81
		300	0.38	176	7.11	88	0.081	72	0.13	-116
		500	0.42	162	4.28	78	0.133	72	0.09	-136
		700	0.43	153	3.16	70	0.183	69	0.07	-163
		1000	0.42	140	2.28	60	0.252	65	0.08	165
		1500	0.47	116	1.66	47	0.357	57	0.12	155
10	10	100	0.53	-83	15.96	124	0.039	58	0.65	-36
		300	0.38	-154	6.44	94	0.070	59	0.35	-41
		500	0.41	-179	3.98	81	0.102	64	0.30	-39
		700	0.42	166	2.94	70	0.138	65	0.27	-39
		1000	0.42	151	2.12	60	0.191	66	0.24	-47
		1500	0.49	125	1.50	44	0.278	63	0.22	-72
	25	100	0.38	-104	20.85	115	0.032	60	0.48	-48
		300	0.32	-169	7.54	91	0.070	68	0.23	-48
		500	0.35	170	4.61	80	0.109	71	0.19	-43
		700	0.37	160	3.37	70	0.152	69	0.16	-39
		1000	0.37	146	2.43	61	0.210	67	0.13	-44
		1500	0.43	121	1.73	47	0.304	61	0.10	-74
	50	100	0.33	-119	22.59	109	0.029	63	0.39	-51
		300	0.30	-176	7.74	88	0.069	72	0.19	-47
		500	0.34	166	4.70	79	0.113	73	0.16	-40
		700	0.36	158	3.45	70	0.156	70	0.14	-35
		1000	0.36	144	2.46	61	0.217	66	0.11	-39
		1500	0.42	119	1.75	47	0.310	60	0.08	-72

MRF961 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$)



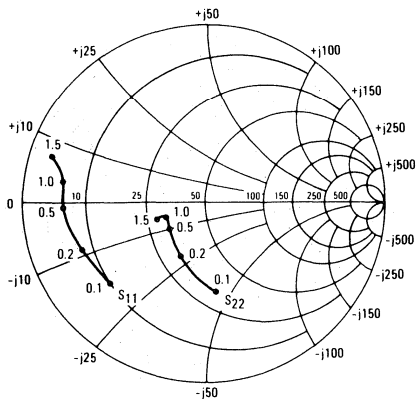
FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$)



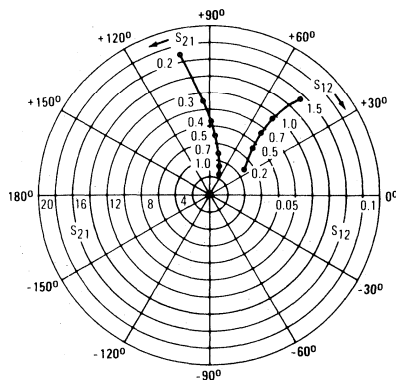
V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle \phi$	$|S_{21}|$	$\angle \phi$	$|S_{12}|$	$\angle \phi$	$|S_{22}|$	$\angle \phi$
5.0	10	100	0.65	-101	16.61	125	0.047	46	0.61	-56
		300	0.64	-160	6.61	96	0.064	39	0.27	-87
		500	0.66	-178	4.01	83	0.078	45	0.19	-98
		700	0.68	171	2.93	73	0.093	49	0.16	-108
		1000	0.68	160	2.07	63	0.119	53	0.16	-124
		1500	0.72	143	1.43	50	0.158	54	0.21	-141
	25	100	0.60	-129	22.41	115	0.034	44	0.49	-84
		300	0.63	-172	7.94	93	0.049	50	0.26	-132
		500	0.66	174	4.78	83	0.071	58	0.21	-150
		700	0.67	166	3.45	75	0.092	60	0.20	-164
		1000	0.67	156	2.46	66	0.124	61	0.21	-177
		1500	0.71	140	1.73	54	0.173	60	0.24	175
	50	100	0.59	-147	25.12	109	0.025	46	0.42	-104
		300	0.64	-178	8.47	91	0.046	60	0.28	-151
		500	0.67	171	5.05	83	0.070	65	0.26	-167
		700	0.68	164	3.67	75	0.093	65	0.25	-178
		1000	0.67	154	2.60	67	0.128	65	0.26	170
		1500	0.72	138	1.83	56	0.178	62	0.29	163
10	10	100	0.65	-90	17.47	128	0.040	50	0.67	-41
		300	0.61	-154	7.31	97	0.057	41	0.33	-57
		500	0.62	-174	4.46	84	0.069	46	0.25	-58
		700	0.64	175	3.27	74	0.084	50	0.22	-60
		1000	0.64	163	2.33	64	0.106	54	0.20	-72
		1500	0.69	145	1.56	50	0.140	57	0.22	-96
	25	100	0.57	-116	24.36	119	0.030	48	0.51	-62
		300	0.58	-167	8.10	94	0.045	52	0.20	-89
		500	0.61	178	5.43	83	0.070	58	0.14	-97
		700	0.63	169	3.93	75	0.084	60	0.10	-106
		1000	0.62	159	2.78	66	0.112	61	0.09	-124
		1500	0.67	142	1.91	53	0.156	60	0.12	-140
	50	100	0.55	-132	26.97	112	0.024	47	0.40	-73
		300	0.57	-173	9.32	91	0.042	59	0.16	-104
		500	0.60	174	5.58	82	0.064	64	0.11	-115
		700	0.62	167	4.04	74	0.086	64	0.08	-128
		1000	0.61	158	2.85	66	0.115	64	0.08	-149
		1500	0.67	141	1.96	55	0.158	61	0.12	-158

MRF962 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$)



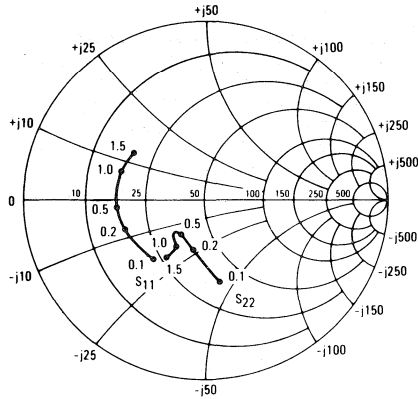
FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$)



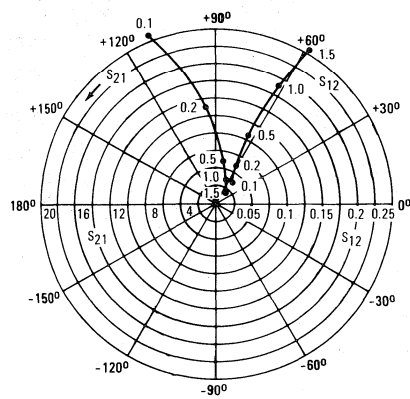
V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle\phi$	$|S_{21}|$	$\angle\phi$	$|S_{12}|$	$\angle\phi$	$|S_{22}|$	$\angle\phi$
5.0	10	100	0.70	-102	17.42	128	0.044	43	0.65	-57
		300	0.75	-156	7.11	98	0.058	24	0.32	-97
		500	0.78	-170	4.36	86	0.064	25	0.26	-110
		700	0.78	-176	3.16	77	0.071	26	0.23	-117
		1000	0.78	176	2.26	67	0.078	27	0.24	-126
		1500	0.79	167	1.51	54	0.092	29	0.31	-133
	25	100	0.69	-131	24.24	118	0.029	38	0.56	-87
		300	0.77	-167	8.76	95	0.039	32	0.35	-137
		500	0.79	-176	5.26	85	0.046	36	0.32	-150
		700	0.80	178	3.82	78	0.055	40	0.31	-158
		1000	0.79	173	2.72	70	0.067	42	0.32	-164
		1500	0.81	164	1.82	59	0.086	42	0.34	-167
	50	100	0.71	-147	27.72	113	0.021	37	0.53	-107
		300	0.78	-173	9.59	94	0.030	40	0.41	-152
		500	0.81	179	5.72	85	0.038	46	0.39	-163
		700	0.81	176	4.09	78	0.048	50	0.38	-169
		1000	0.81	171	2.89	71	0.061	51	0.38	-175
		1500	0.82	163	1.96	62	0.082	49	0.40	-177
10	10	100	0.71	-92	18.77	131	0.037	47	0.70	-44
		300	0.74	-150	8.09	100	0.051	28	0.34	-69
		500	0.75	-166	5.01	87	0.056	28	0.27	-75
		700	0.76	-174	3.62	78	0.064	28	0.24	-79
		1000	0.76	179	2.58	69	0.071	30	0.24	-88
		1500	0.77	168	1.72	55	0.085	31	0.31	-104
	25	100	0.67	-120	27.10	122	0.027	42	0.57	-68
		300	0.73	-163	10.27	97	0.035	36	0.27	-110
		500	0.76	-174	6.21	86	0.043	39	0.22	-124
		700	0.77	-179	4.48	78	0.051	41	0.20	-132
		1000	0.77	175	3.19	71	0.062	43	0.20	-139
		1500	0.78	166	2.13	59	0.080	42	0.25	-142
	50	100	0.68	-137	31.53	116	0.020	37	0.49	-85
		300	0.74	-169	11.17	95	0.028	40	0.27	-131
		500	0.77	-177	6.69	85	0.037	46	0.24	-144
		700	0.77	178	4.82	78	0.047	48	0.23	-152
		1000	0.77	173	3.42	71	0.059	50	0.23	-158
		1500	0.79	165	2.30	61	0.078	47	0.27	-159

MRF965 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$)

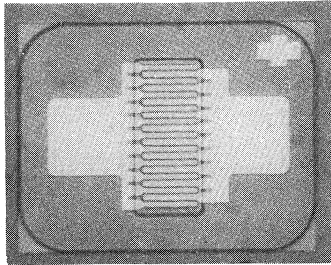


FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle \phi$	$|S_{21}|$	$\angle \phi$	$|S_{12}|$	$\angle \phi$	$|S_{22}|$	$\angle \phi$
5.0	10	100	0.56	-102	13.87	121	0.054	48	0.58	-62
		300	0.57	-158	5.47	90	0.084	46	0.32	-94
		500	0.56	-169	3.40	77	0.110	52	0.27	-106
		700	0.52	178	2.53	69	0.136	54	0.39	-115
		1000	0.55	167	1.79	57	0.181	56	0.35	-112
		1500	0.54	150	1.27	42	0.242	57	0.43	-122
	25	100	0.48	-129	17.61	112	0.041	51	0.47	-85
		300	0.55	-169	6.38	89	0.076	57	0.30	-125
		500	0.54	-176	3.97	77	0.111	62	0.27	-138
		700	0.50	172	2.94	71	0.114	61	0.30	-143
		1000	0.53	162	2.08	61	0.198	60	0.32	-135
		1500	0.50	146	1.50	47	0.267	57	0.37	-140
	50	100	0.47	-144	19.34	107	0.035	56	0.42	-100
		300	0.55	-173	6.72	87	0.073	63	0.31	-138
		500	0.53	-179	4.17	77	0.112	66	0.29	-150
		700	0.50	168	3.10	71	0.147	64	0.33	-153
		1000	0.53	159	2.19	62	0.206	61	0.32	-146
		1500	0.50	143	1.59	49	0.277	58	0.36	-149
10	10	100	0.56	-92	14.67	123	0.047	50	0.63	-50
		300	0.53	-152	6.00	92	0.077	47	0.34	-73
		500	0.53	-165	3.74	78	0.100	53	0.29	-82
		700	0.49	-177	2.76	70	0.124	56	0.31	-93
		1000	0.52	170	1.96	57	0.166	58	0.38	-94
		1500	0.51	153	1.36	42	0.221	59	0.46	-108
	25	100	0.46	-117	19.10	115	0.036	53	0.49	-68
		300	0.50	-164	7.09	90	0.071	57	0.26	-99
		500	0.49	-172	4.39	78	0.102	62	0.23	-110
		700	0.45	175	3.25	71	0.133	61	0.25	-119
		1000	0.49	164	2.28	60	0.181	61	0.30	-112
		1500	0.47	148	1.61	46	0.246	59	0.37	-120
	50	100	0.42	-131	20.99	110	0.033	56	0.41	-79
		300	0.49	-169	7.46	88	0.069	62	0.24	-111
		500	0.48	-175	4.63	78	0.103	65	0.21	-123
		700	0.45	172	3.40	71	0.136	64	0.25	-129
		1000	0.48	162	2.39	61	0.188	62	0.29	-119
		1500	0.45	146	1.70	48	0.251	59	0.35	-126

BFRC96 CHIP TOPOGRAPHY



Nominal Chip Size: 0.014" X 0.016" X 0.005"

Front Metalization: Gold

Back Metalization: Gold

Emitter/Base Bond Pad: 2.8 mil Dia.

#Emitter Fingers: 10

#Base Fingers: 11

Emitter Diffusion: Ion-Implanted Arsenic

BFW92A

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

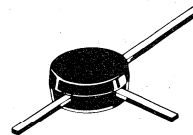
... designed primarily for use in MATV/CATV amplifiers and other broadband linear applications demanding high power gain with low noise over a wide current range.

- High Power Gain —
MAG = 16 dB (Typ) @ $f = 0.5$ GHz
- Low Noise Figure —
NF = 2.7 dB (Typ) @ $f = 0.5$ GHz
- Ion-Implanted Arsenic Emitters
- Gold Top Metal
- Silicon Nitride Passivation
- Industry Standard Plastic Macro-T Package
- Compatible with Other BFW92 Types

$f_T = 4.5$ GHz @ 10 mA

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON



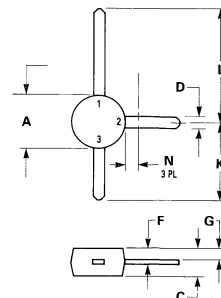
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	35	mA dc
Total Device Dissipation @ $T_C = 105^\circ\text{C}$ Derate Above 105°C	P_D	180 4.0	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to 150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Case (2)	$R_{\theta JC}$	250	$^\circ\text{C}/\text{W}$

Note: Case temperature measured on collector lead immediately adjacent to body of package



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

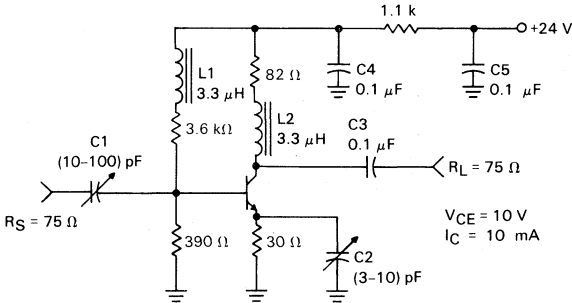
CASE 317A-01

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mA, I _B = 0)	V _{(BR)CEO}	15	—	—	V _{dc}
Collector-Base Breakdown Voltage (I _C = 0.1 mA, I _E = 0)	V _{(BR)CBO}	25	—	—	V _{dc}
Emitter-Base Breakdown Voltage (I _E = 0.1 mA, I _C = 0)	V _{(BR)EBO}	2.5	—	—	V _{dc}
Collector Cutoff Current (V _{CB} = 10 V _{dc} , I _E = 0)	I _{CBO}	—	—	50	nA _{dc}
ON CHARACTERISTICS					
DC Current Gain (I _C = 2.0 mA, V _{CE} = 1.0 V _{dc})	h _{FE}	20	50	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I _C = 10 mA, V _{CE} = 10 V _{dc} , f = 0.5 GHz)	f _T	—	4.5	—	GHz
Collector-Base Capacitance (V _{CB} = 10 V _{dc} , f = 1.0 MHz, Emitter Guarded)	C _{cb}	—	0.5	1.0	pF
FUNCTIONAL PERFORMANCE					
Optimum Noise Figure (Tuned) (I _C = 10 mA, V _{CE} = 10 V _{dc} , f = 0.5 GHz)	NF _{opt}	—	2.7	—	dB
Noise Figure (Untuned, R _S = R _L = 50 Ω) (I _C = 10 mA, V _{CE} = 10 V _{dc} , f = 0.5 GHz)	NF	—	3.0	—	dB
Maximum Available Gain (1) (I _C = 10 mA, V _{CE} = 10 V _{dc} , f = 0.5 GHz)	MAG	—	16	—	dB
Insertion Gain (I _C = 10 mA, V _{CE} = 10 V _{dc} , f = 0.5 GHz)	|S ₂₁|²	—	14	—	dB

(1) $G_{\max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 1 — 30-900 MHz BROADBAND AMPLIFIER



C3, C4, C5 — 0.1 μF Chip Capacitor
L1, L2 — 3.3 μH Molded Inductor

All Resistors 1/4 W, 20%

FIGURE 2 — BROADBAND GAIN (Circuit Figure 1)

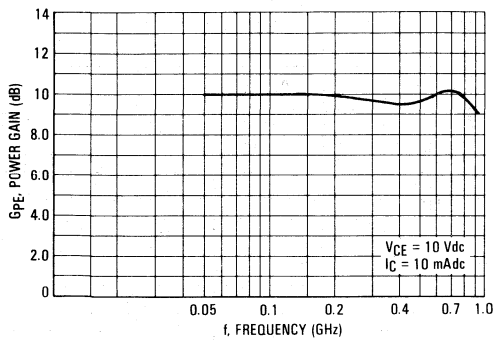


FIGURE 3 — 2nd AND 3rd ORDER INTERCEPT POINTS

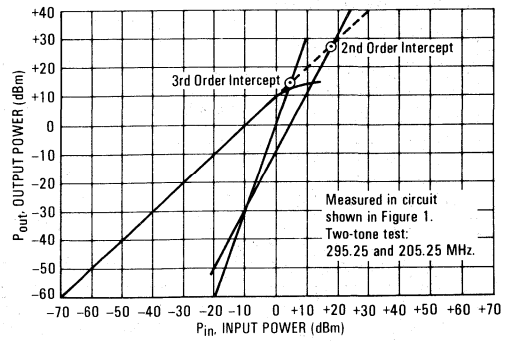
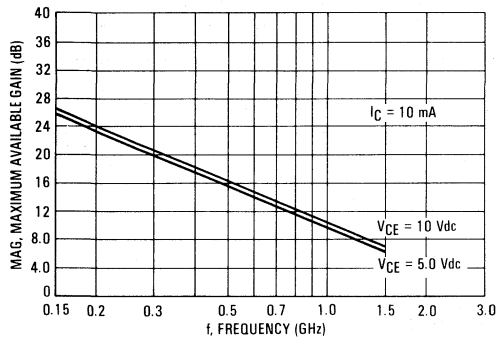
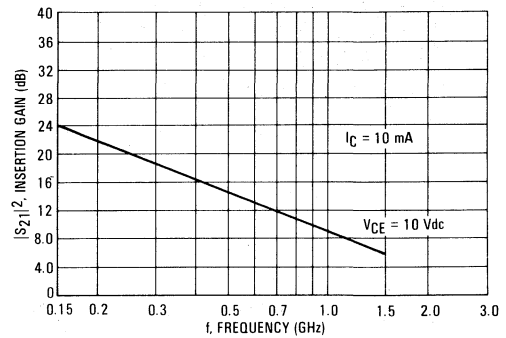
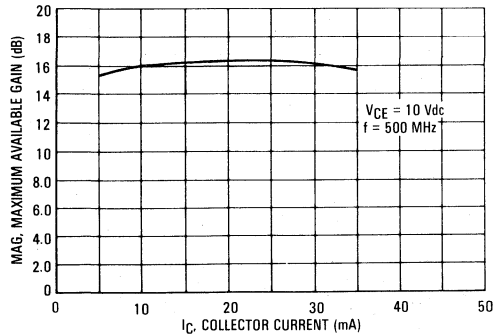
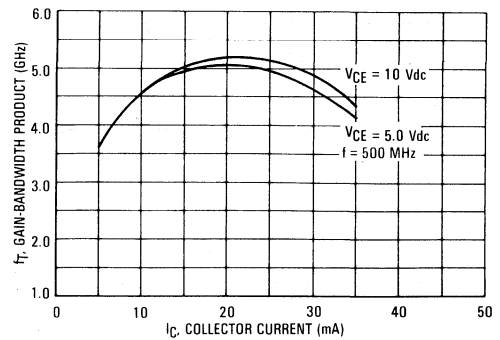
FIGURE 4 — MAXIMUM AVAILABLE GAIN
versus FREQUENCYFIGURE 5 — $|S_{21}|^2$ versus FREQUENCYFIGURE 6 — MAXIMUM AVAILABLE GAIN
versus COLLECTOR CURRENTFIGURE 7 — GAIN-BANDWIDTH PRODUCT
versus COLLECTOR CURRENT

FIGURE 8 — NOISE FIGURE
versus COLLECTOR CURRENT

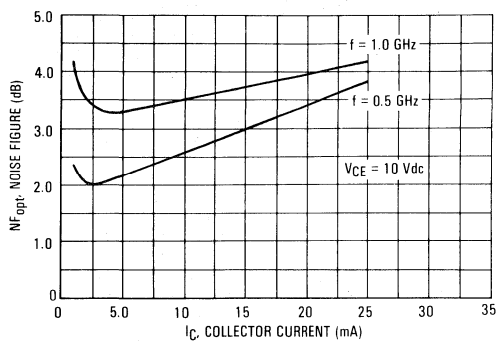


FIGURE 9 — NOISE FIGURE
versus COLLECTOR CURRENT
Untuned, R_S = R_L = 50 Ω

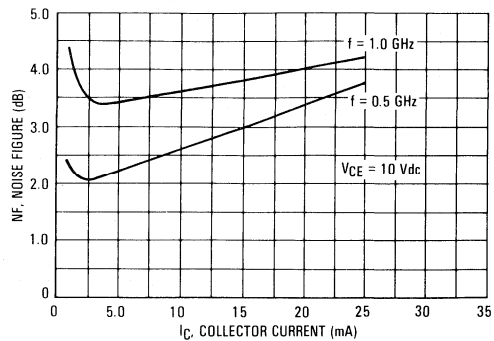


FIGURE 10 — NOISE FIGURE versus FREQUENCY

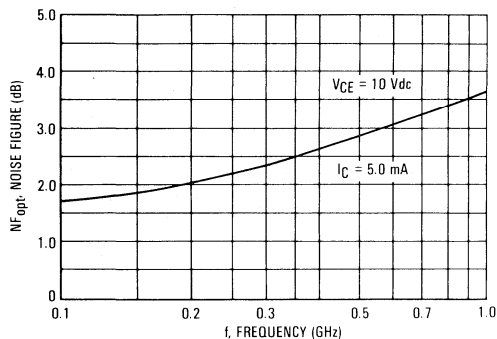


FIGURE 11 — NOISE FIGURE versus FREQUENCY
Untuned R_S = R_L = 50 Ω

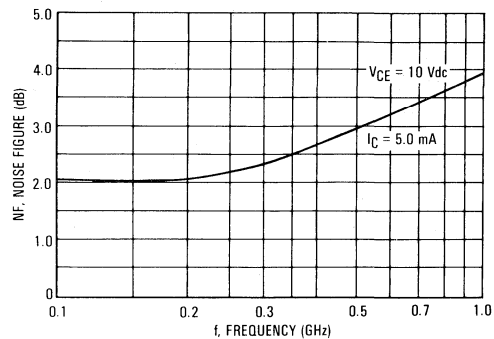


FIGURE 12 — C_{ib} INPUT CAPACITANCE versus
EMITTER BASE VOLTAGE

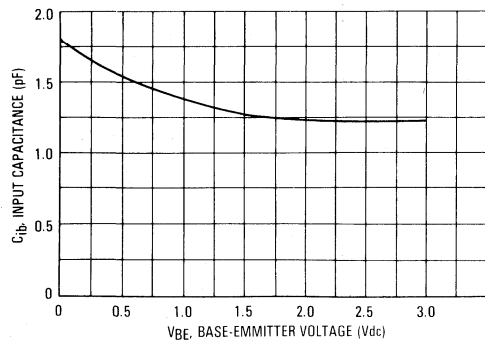
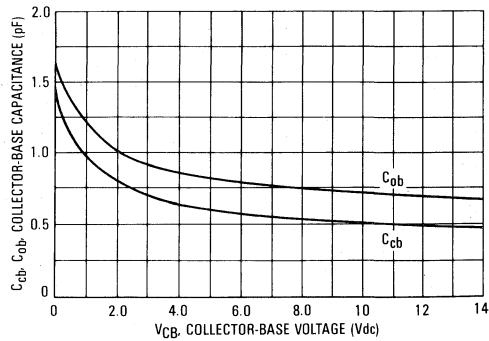
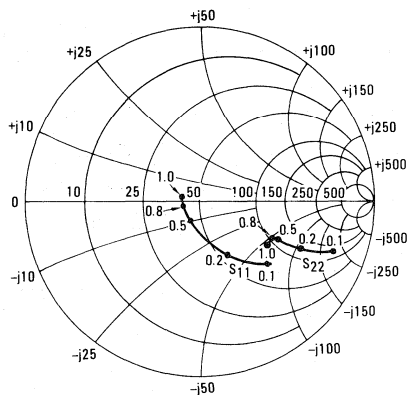


FIGURE 13 — COLLECTOR-BASE CAPACITANCE
versus COLLECTOR-BASE VOLTAGE

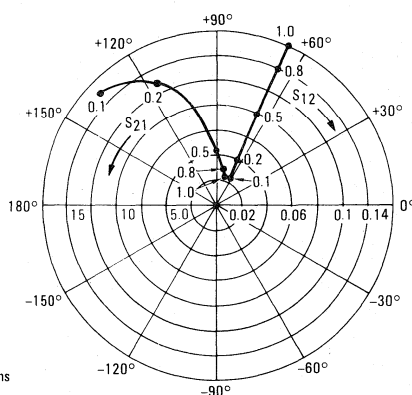


BFW92A COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$)



FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY
($V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle \phi$	$|S_{21}|$	$\angle \phi$	$|S_{12}|$	$\angle \phi$	$|S_{22}|$	$\angle \phi$
5.0	5.0	100	0.71	-33	11.2	145	0.031	69	0.87	-18
		200	0.49	-60	8.6	122	0.052	62	0.70	-26
		500	0.21	-119	4.5	92	0.094	61	0.48	-30
		800	0.17	-161	3.0	78	0.137	60	0.44	-36
		1000	0.16	176	2.5	71	0.164	60	0.44	-40
	10	100	0.52	-46	16.6	135	0.027	67	0.78	-23
		200	0.31	-75	11.2	113	0.044	65	0.58	-29
		500	0.14	-150	5.2	88	0.089	67	0.40	-29
		800	0.15	173	3.3	76	0.135	65	0.37	-34
		1000	0.16	154	2.8	70	0.164	64	0.37	-38
	15	100	0.40	-55	19.7	129	0.025	69	0.72	-26
		200	0.22	-88	12.1	109	0.041	68	0.52	-29
		500	0.14	-170	5.4	86	0.087	70	0.36	-27
		800	0.16	161	3.5	76	0.134	68	0.34	-33
		1000	0.17	145	2.9	69	0.164	66	0.35	-37
	20	100	0.33	-62	21.1	125	0.023	69	0.68	-27
		200	0.18	-99	12.5	106	0.039	69	0.49	-28
		500	0.14	178	5.5	85	0.086	72	0.35	-26
		800	0.17	155	3.5	75	0.133	69	0.33	-32
		1000	0.18	142	2.9	69	0.164	67	0.34	-37
	25	100	0.27	-69	21.9	122	0.022	70	0.65	-27
		200	0.15	-111	12.7	104	0.038	71	0.47	-27
		500	0.16	172	5.5	85	0.085	73	0.35	-25
		800	0.19	153	3.5	75	0.132	70	0.33	-31
		1000	0.20	140	2.9	69	0.163	68	0.33	-36
10	5.0	100	0.73	-30	11.1	146	0.026	71	0.90	-14
		200	0.53	-52	8.8	124	0.044	63	0.75	-21
		500	0.21	-98	4.7	94	0.082	62	0.57	-25
		800	0.14	-136	3.1	80	0.120	62	0.53	-30
		1000	0.11	-161	2.6	73	0.143	62	0.53	-34
	10	100	0.57	-39	16.7	137	0.023	70	0.82	-18
		200	0.35	-62	11.5	115	0.038	66	0.65	-23
		500	0.12	-117	5.4	89	0.078	69	0.50	-23
		800	0.09	-163	3.5	78	0.118	67	0.47	-28
		1000	0.09	168	2.9	71	0.144	66	0.48	-32
	15	100	0.46	-46	19.9	130	0.021	70	0.77	-20
		200	0.26	-68	12.6	110	0.035	68	0.60	-22
		500	0.09	-137	5.6	87	0.076	71	0.47	-21
		800	0.09	177	3.7	77	0.117	69	0.45	-27
		1000	0.10	153	3.0	71	0.143	68	0.46	-31
	20	100	0.39	-50	21.5	126	0.020	70	0.74	-21
		200	0.21	-73	13.0	107	0.034	71	0.58	-21
		500	0.08	-154	5.7	86	0.075	72	0.46	-20
		800	0.10	168	3.7	76	0.117	70	0.45	-27
		1000	0.11	148	3.0	71	0.142	69	0.45	-31
	25	100	0.34	-54	22.3	123	0.019	70	0.71	-20
		200	0.17	-79	13.0	105	0.033	71	0.57	-20
		500	0.08	-166	5.7	86	0.075	73	0.47	-19
		800	0.11	162	3.7	76	0.116	70	0.45	-26
		1000	0.13	144	3.0	70	0.141	69	0.46	-30

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

... designed for VHF and UHF applications where high-gain, low-noise and good intermodulation characteristics are required. Particularly suited for wideband MATV amplifiers.

- High Current-Gain — Bandwidth Product — f_T
1.2 GHz (Min) @ $I_C = 25$ mAdc — BFX89
1.3 GHz (Min) @ $I_C = 25$ mAdc — BFY90
- Low Noise Figure — NF
6.5 dB (Max) @ $f = 500$ MHz — BFX89
5.0 dB (Max) @ $f = 500$ MHz — BFY90
- High Power Gain — G_{pe}
19 dB (Min) @ $f = 200$ MHz — BFX89
21 dB (Typ) @ $f = 200$ MHz — BFY90
- JEDEC Equivalents — 2N6304, 2N6305

MAXIMUM RATINGS

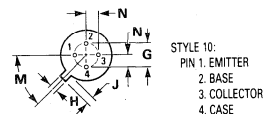
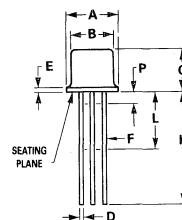
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	50	mAdc
Total Continuous Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	200 1.14	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

BFX89
BFY90

$f_T = 2.0$ GHz @ 10 mA

HIGH FREQUENCY TRANSISTORS

NPN SILICON



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0)	V _{(BR)CEO}	15	—	—	Vdc
Collector Cutoff Current (V _{CE} = 15 Vdc, I _E = 0)	I _{CBO}	—	—	10	nAdc
ON CHARACTERISTICS					
DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 25 mAdc, V _{CE} = 1.0 Vdc)	h _{FE}	25 20	— —	150 125	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (1) (V _{CE} = 10 Vdc, I _E = 0, f = 1.0 MHz)	BFX89 BFY90 C _{cb0}	— —	0.85 0.85	1.7 1.5	pF
Emitter-Base Capacitance (V _{EB} = 0.5 Vdc, I _C = 0, f = 1.0 MHz)	BFY90 C _{ib0}	—	—	2.0	pF
Current-Gain-Bandwidth Product (2) (I _C = 2.0 mA, V _{CE} = 5.0 Vdc, f = 500 MHz)	BFX89 BFY90 f _T	— 1.0 1.2	1.0 — 1.7	— — —	GHz
(I _C = 25 mA, V _{CE} = 5.0 Vdc, f = 500 MHz)	BFX89 BFY90	1.3 —	— —	— —	
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (2) (V _{CE} = 10 Vdc, I _C = 8.0 mA, f = 200 MHz)	BFX89 BFY90 G _{pe}	19 —	— 21	— —	dB
Spot Noise Figure (R _S = Optimum) (2) (V _{CE} = 5.0 Vdc, I _C = 2.0 mA, f = 500 MHz)	BFX89 BFY90 NF	— —	2.5 2.5	6.5 5.0	dB

- Notes 1. Pin 4 is not grounded.
2. Pin 4 is grounded.
3. G_U(max) is calculated from the S-Parameters using the equation $G_U(\max) = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

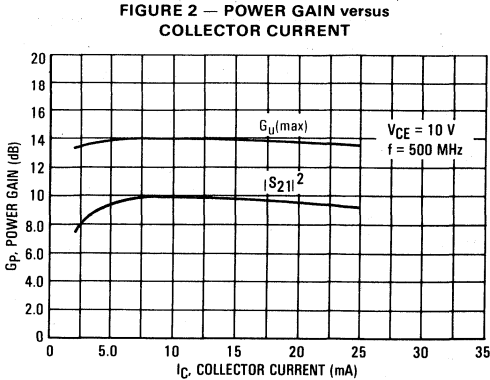
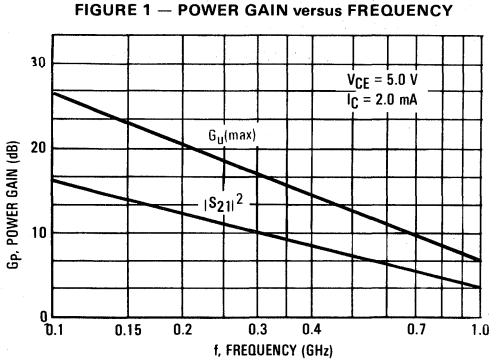


FIGURE 3 — NOISE FIGURE versus FREQUENCY

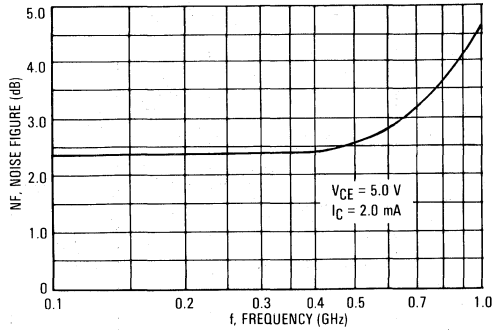


FIGURE 4 — NOISE FIGURE versus COLLECTOR CURRENT

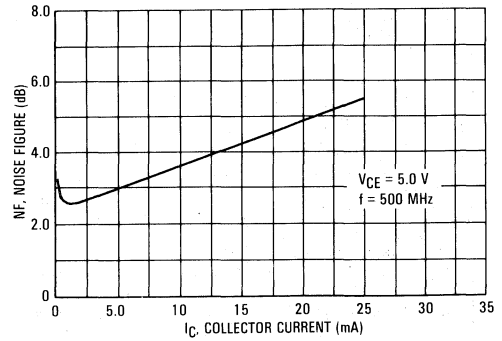


FIGURE 5 — CURRENT GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

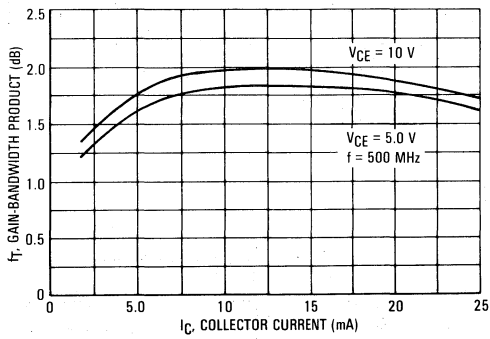
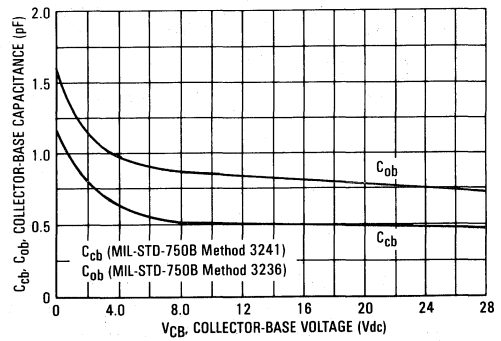


FIGURE 6 — OUTPUT CAPACITANCE versus VOLTAGE



COMMON EMITTER SCATTERING PARAMETERS

FIGURE 7 — INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY

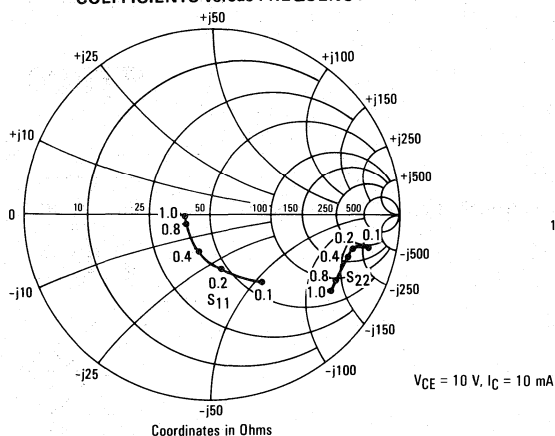
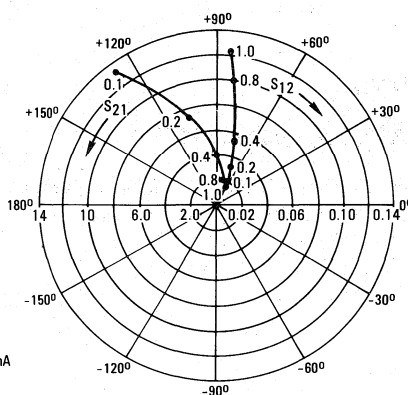


FIGURE 8 — FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY



S — PARAMETERS

V _{CE} (Volts)	I _C (mA)	Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
5.0	2.0	100	0.81	-37	5.76	148	0.031	72	0.95	-11
		200	0.64	-66	4.56	127	0.050	63	0.87	-17
		400	0.41	-105	2.91	102	0.071	62	0.79	-23
		800	0.26	-157	1.63	77	0.105	74	0.75	-34
		1000	0.23	179	1.38	68	0.129	80	0.74	-41
	5.0	100	0.60	-54	9.73	133	0.026	68	0.87	-13
		200	0.41	-84	6.33	112	0.040	66	0.78	-17
		400	0.26	-121	3.54	92	0.064	72	0.73	-21
		800	0.19	-169	1.89	72	0.112	80	0.72	-31
		1000	0.17	168	1.59	64	0.140	82	0.71	-39
	10	100	0.71	-66	12.13	122	0.022	70	0.81	-14
		200	0.28	-96	7.11	104	0.036	71	0.73	-15
		400	0.19	-133	3.85	88	0.064	77	0.70	-19
		800	0.18	-178	2.00	69	0.115	83	0.71	-30
		1000	0.17	160	1.66	61	0.143	84	0.70	-37
	25	100	0.26	-88	12.79	112	0.019	73	0.76	-13
		200	0.20	-122	7.04	97	0.034	76	0.71	-13
		400	0.20	-156	3.68	83	0.062	81	0.70	-18
		800	0.23	165	1.88	65	0.114	86	0.71	-30
		1000	0.24	146	1.56	58	0.145	88	0.70	-38
10	2.0	100	0.83	-34	5.82	150	0.025	73	0.96	-9
		200	0.66	-61	4.60	129	0.042	65	0.89	-15
		400	0.42	-97	2.98	104	0.059	64	0.83	-20
		800	0.25	-147	1.69	79	0.088	77	0.80	-31
		1000	0.20	-172	1.42	70	0.108	82	0.79	-38
	5.0	100	0.63	-48	9.94	135	0.021	70	0.90	-11
		200	0.43	-76	6.54	114	0.034	68	0.82	-15
		400	0.26	-108	3.72	94	0.054	73	0.77	-19
		800	0.16	-155	1.98	74	0.095	83	0.77	-24
		1000	0.14	180	1.65	66	0.119	85	0.76	-36
	10	100	0.47	-57	12.42	125	0.019	70	0.85	-12
		200	0.30	-83	7.43	106	0.031	72	0.78	-14
		400	0.19	-113	4.04	90	0.054	78	0.75	-18
		800	0.14	-160	2.09	71	0.098	84	0.75	-28
		1000	0.13	173	1.73	64	0.121	86	0.75	-35
	25	100	0.32	-71	13.05	114	0.017	72	0.81	-11
		200	0.21	-99	7.27	99	0.029	76	0.77	-12
		400	0.16	-135	3.81	85	0.052	81	0.76	-16
		800	0.17	177	1.96	68	0.096	87	0.76	-28
		1000	0.18	154	1.62	61	0.120	89	0.76	-35

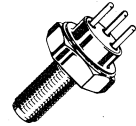
The RF Line RF Bias Source

... designed for use in Class AB amplifiers to provide a thermally tracked bias source.

- Gold Metallized Die for Improved Reliability
- Hermetic Package

BT500

**BIAS SOURCE
FOR
CLASS AB
RF DEVICES**



CASE 036-03, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Emitter-Base Breakdown Voltage ($I_E = 5 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Emitter-Base Forward Voltage ($I_E = 500 \text{ mA}$)	V_f	1	—	1.3	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100 \text{ mA}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	100	—
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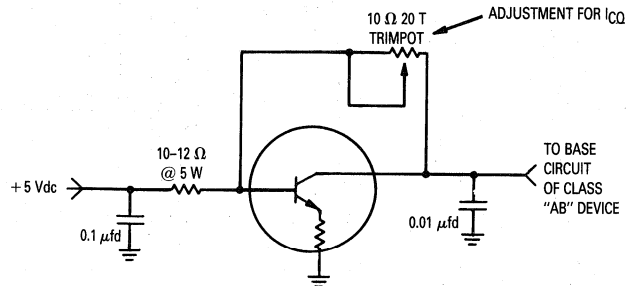


Figure 1. Suggested Circuit for BT500

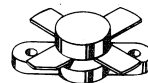
The RF Line
RF Bias Source

... designed for use in Class AB amplifiers to provide a thermally tracked bias source.

- Gold Metallized Die for Improved Reliability
- Isolated SOE Style Package

BT500F

**BIAS SOURCE
 FOR
 CLASS AB
 RF DEVICES**



**.380 SOE F
 CASE 211-07, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Emitter-Base Breakdown Voltage ($I_E = 5 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Emitter-Base Forward Voltage ($I_E = 500 \text{ mA}$)	V_f	1	—	1.3	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100 \text{ mA}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	100	—
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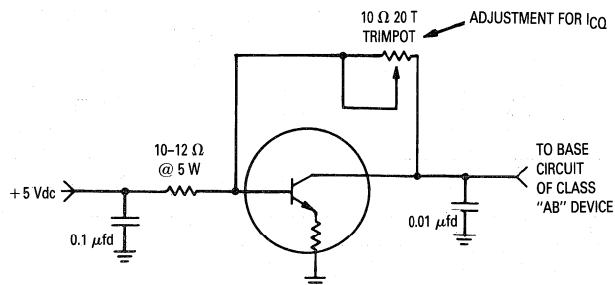


Figure 1. Suggested Circuit for BT500F

The RF Line

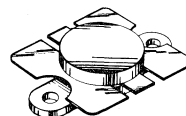
VHF Power Transistor

... designed primarily for wideband large-signal output amplifier stages in 30–200 MHz frequency range.

- Guaranteed Performance at 175 MHz and 28 Vdc
 Output Power = 100 W
 Minimum Gain = 7 dB
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at All Phase Angles with 3:1 VSWR
- Gold Metallization System for High Reliability
- High Output Saturation Power — $P_{sat} = 125$ W (Min)
- Diffused Ballast Resistors

J01006

28 VOLTS
30–200 MHz
VHF POWER
TRANSISTOR



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CES}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	12	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	150 1.14	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	– 65 to + 150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.88	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 25$ V, $V_{BE} = 0$)	I_{CES}	—	—	10	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 10$ V)	h_{FE}	20	—	150	—
---	----------	----	---	-----	---

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	200	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28 \text{ V}$, $P_{out} = 100 \text{ W}$, $f = 175 \text{ MHz}$)	G_{PE}	7	—	—	dB
Collector Efficiency ($V_{CE} = 28 \text{ V}$, $P_{out} = 100 \text{ W}$, $f = 175 \text{ MHz}$)	η_c	—	60	—	%
Load Mismatch ($V_{CE} = 28 \text{ V}$, $P_{out} = 100 \text{ W}$, $f = 175 \text{ MHz}$, Load VSWR = 3:1, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28 \text{ V}$, $f = 175 \text{ MHz}$)	P_{sat}	125	—	—	W

TYPICAL CHARACTERISTICS

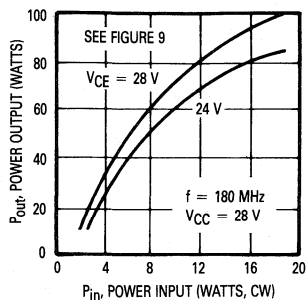


Figure 1. Power Input versus Power Output
(Class C Narrowband)

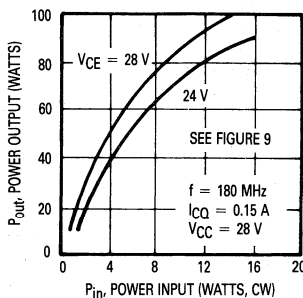


Figure 2. Power Input versus Power Output
(Class B Narrowband)

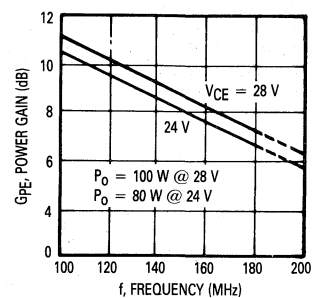


Figure 3. Power Gain versus Frequency
(Class C Narrowband)

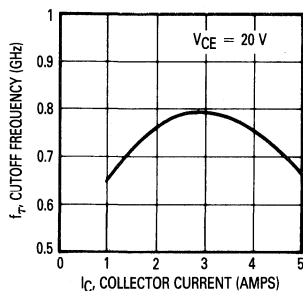


Figure 4. Cutoff Frequency versus Current

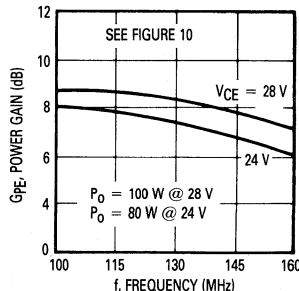


Figure 5. Power Gain versus Frequency
(Broadband)

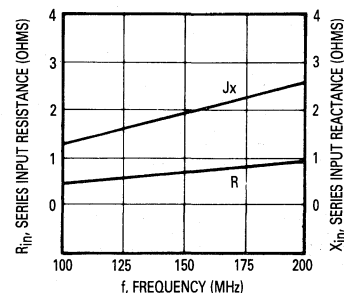


Figure 6. Series Input Impedance versus Frequency

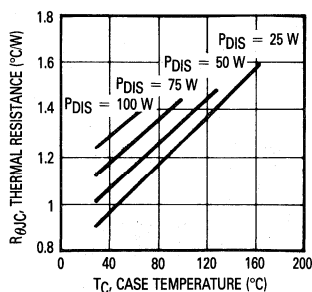


Figure 7. Thermal Resistance versus Case Temperature

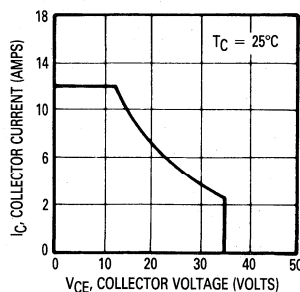
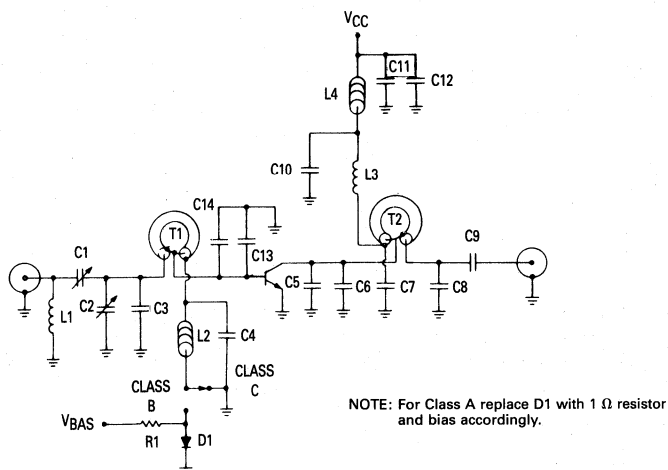


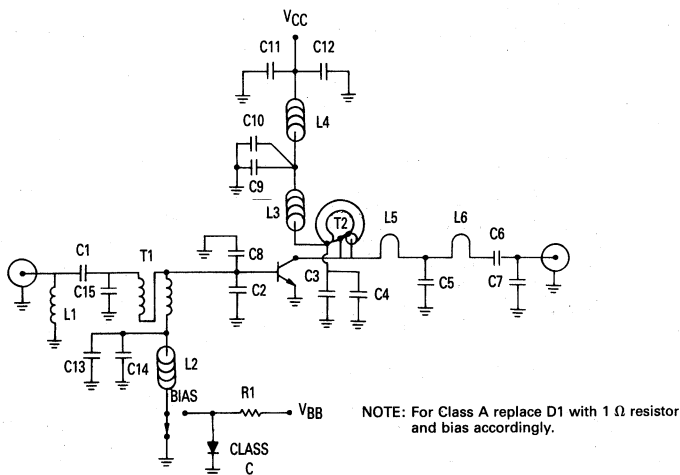
Figure 8. DC Safe Operating Area



C1 — 8–60 pF ARCO
 C2 — 3–35 pF ARCO
 C3 — 30 pF UNELCO
 C4, C7, C9, C10, C11 — 1000 pF UNELCO
 C5 — 110 pF UNELCO
 C6 — 120 pF UNELCO
 C8 — 40 pF UNELCO
 C12 — 25 μ F Electrolytic

C13 — 350 pF UNELCO
 C14 — 300 pF UNELCO
 D1 — DSR 5050
 L1 — 5 turns, 0.125" diameter #22 AWG
 L2, L4 — 3 Ferrite beads
 R1 — 12 Ω
 T1 — 0.075" diameter semiridged 10 Ω co-ax
 T2 — 0.075" diameter semiridged 25 Ω co-ax

Figure 9. Narrowband Test Circuit (100–180 MHz)



C1 — 50 pF UNELCO
 C2 — 350 pF UNELCO
 C3, C6, C9, C12, C14 — 1000 pF UNELCO
 C4, C10, C13 — 0.1 μ F disc
 C5, C15 — 30 pF UNELCO
 C7 — 0–18 pF #402 ARCO
 C8 — 300 pF UNELCO
 C11 — 100 μ F Electrolytic
 D1 — DSR 5050

L1 — 4 turns, 0.125" diameter #22 AWG
 L2, L3, L4 — 3 Ferrite Beads on #22 AWG
 L5 — 0.08" wide ribbon, 0.25" long
 L6 — 0.08" wide ribbon, 0.125" long
 R1 — 50 Ω
 T1 — 1" long twisted pair #22 AWG
 T2 — 0.075" diameter semiridged 25 Ω co-ax, 2" long (Balun transformer)

Figure 10. Broadband Test Circuit (100–160 MHz)

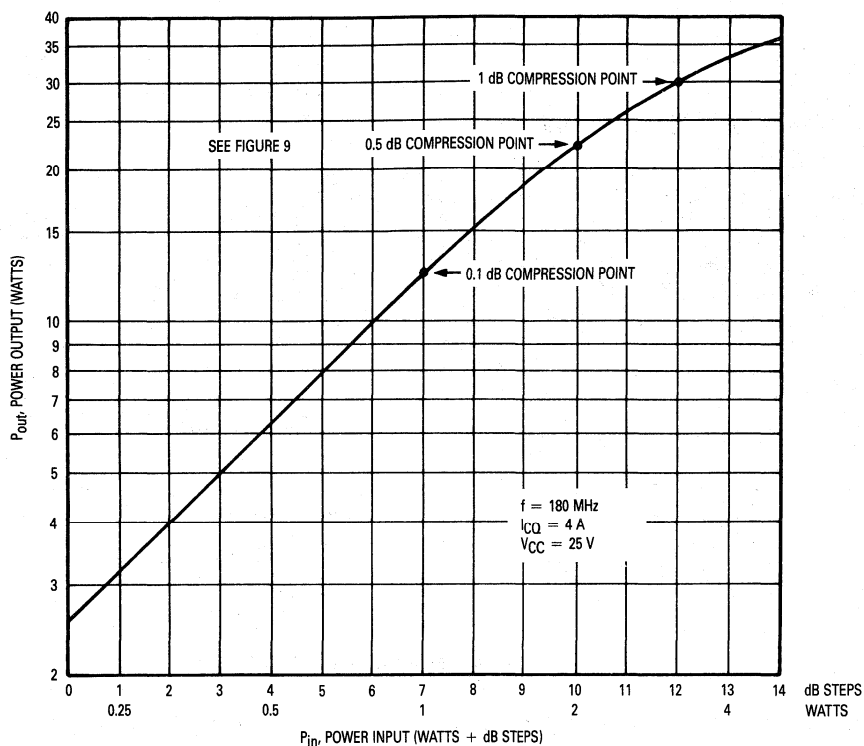
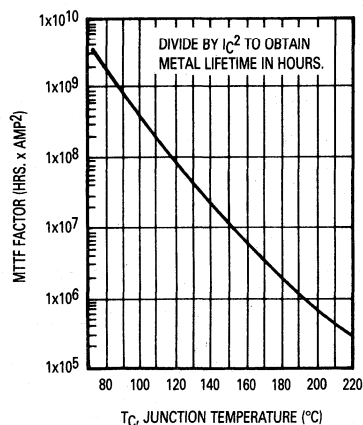


Figure 11. Power Input versus Power Output
(Class A Narrowband)



Conditions:

$P_o = 100 \text{ W}$
 $\eta_c = 60\%$
 $G_T = 7 \text{ dB}$
 $T_C = 45^\circ\text{C}$
 $\theta_{JC} = 1.25$
 $V_{CE} = 28 \text{ V}$
 $P_{DJS} = 87 \text{ W}$
 $T_J = 150^\circ\text{C}$

$$\text{MTTF Factor} = (1 \times 10^7 \text{ hrs.}) (\text{amp}^2)$$

$$\begin{aligned} \text{MTTF (hr)} &= \frac{(1 \times 10^7 \text{ hrs}) (\text{amp}^2)}{(5.95 \text{ amp})^2} \\ &= 2.8 \times 10^5 \text{ hrs} \\ &= 32 \text{ yrs} \end{aligned}$$

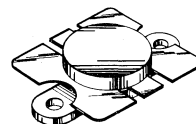
Figure 12. MTTF Factor versus Junction Temperature

The RF Line

UHF Power Transistor

JO2015A

50 W — 400 MHz
UHF POWER
TRANSISTOR



.500 J ZERO
CASE 316A-01, STYLE 1

The JO2015A is an internally matched NPN silicon UHF power transistor. Its multicell design allows optimum heat dissipation and operating efficiency. A slotted-grid finger structure assures uniform current injection. Ruggedability and long-term reliability are guaranteed by unique, diffused silicon ballasting resistors coupled with a refractory-gold passivated metallization system.

- 50 W — P_{out} (65 W — P_{sat})
- 28 V — V_{CC}
- 225–400 MHz
- Internally Matched
- Gold Metallization

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	– 65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 10\text{ V}$)	h_{FE}	10	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	80	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 50\text{ W}$, $f = 400\text{ MHz}$, $I_Q = 100\text{ mA}$)	G_{PE}	10	—	—	dB
Collector Efficiency ($V_{CE} = 28\text{ V}$, $I_Q = 100\text{ mA}$, $P_{out} = 50\text{ W}$, $f = 400\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 50\text{ W}$, $f = 400\text{ MHz}$, Load VSWR = 10:1, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28\text{ V}$, $f = 400\text{ MHz}$, $I_Q = 100\text{ mA}$)	P_{sat}	65	—	—	W

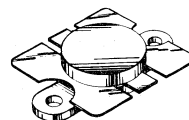
The RF Line
NPN Silicon
UHF Power Transistor

The JO2017 is an internally matched NPN silicon UHF power transistor. Its multicell design allows optimum heat dissipation and operating efficiency. A slotted-grid finger structure assures uniform current injection. Ruggedness and long-term reliability are guaranteed by unique, diffused silicon ballasting resistors coupled with a refractory-gold-passivated metallization system.

- 65 W P_O (Typ)
- 23 V V_{CC}
- 410–440 MHz
- Internally Matched
- Gold Metallization

JO2017

23 VOLT
440 MHz
UHF POWER TRANSISTOR
NPN SILICON



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$	P_D	250	Watts
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$)	$V_{(BR)CEO}$	30	—	—	V
Collector-Base Breakdown Voltage ($I_C = 100\text{ mA}$)	$V_{(BR)CBO}$	65	—	—	V
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$)	$V_{(BR)EBO}$	3.5	—	—	V

ON CHARACTERISTICS

DC Current Gain ($V_{CE} = 10\text{ V}$, $I_C = 1\text{ A}$)	h_{FE}	10	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $f = 1\text{ MHz}$)	C_{ob}	—	—	160	pF
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FUNCTIONAL TESTS

Output Power ($V_{CE} = 23\text{ V}$, $P_{out} = 60\text{ W}$, $f = 440\text{ MHz}$, $P_{in} = 12\text{ W}$)	P_{out}	60	65	—	Watts
Efficiency	η_c	55	—	—	%

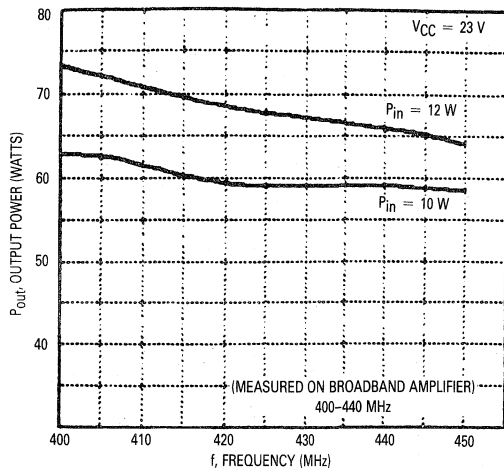


Figure 1. Output Power versus Frequency

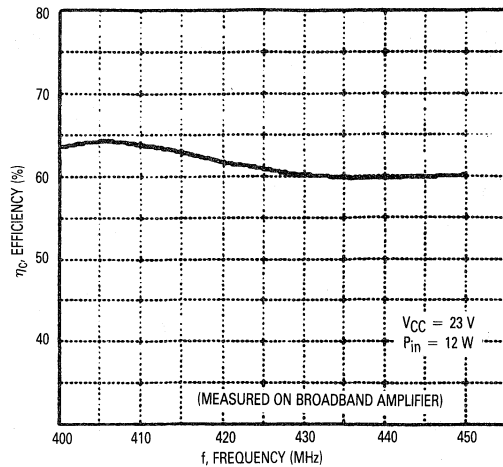


Figure 2. Efficiency versus Frequency

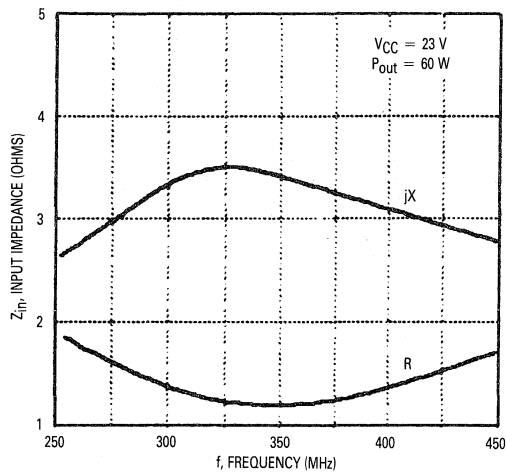


Figure 3. Input Impedance versus Frequency

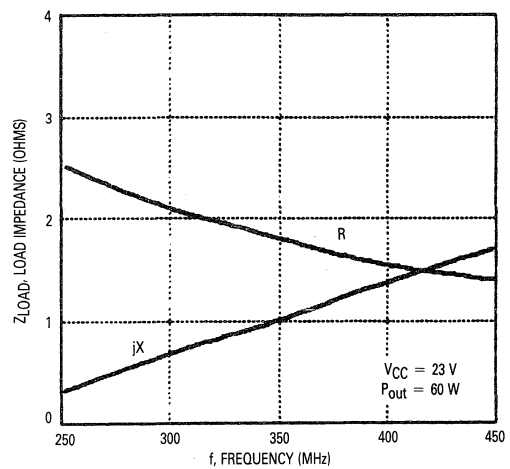


Figure 4. Load Impedance versus Frequency

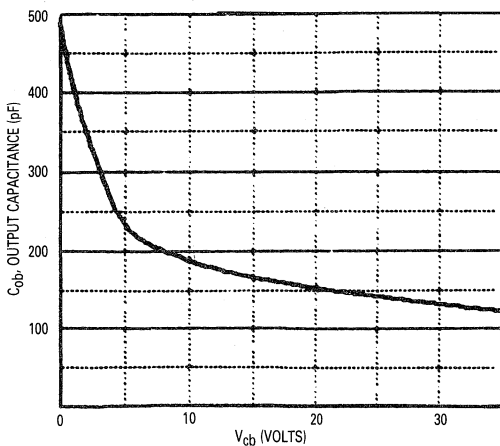


Figure 5. Collector-to-Base Capacitance versus Voltage

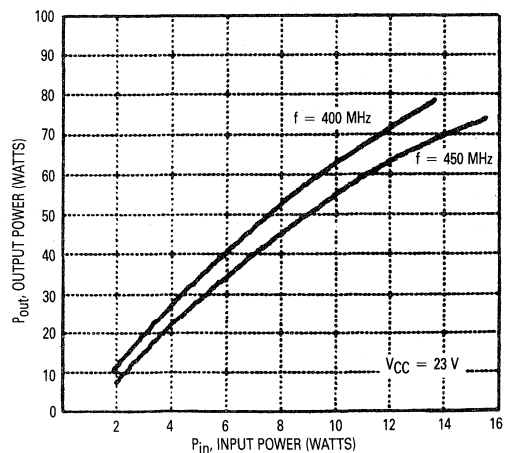
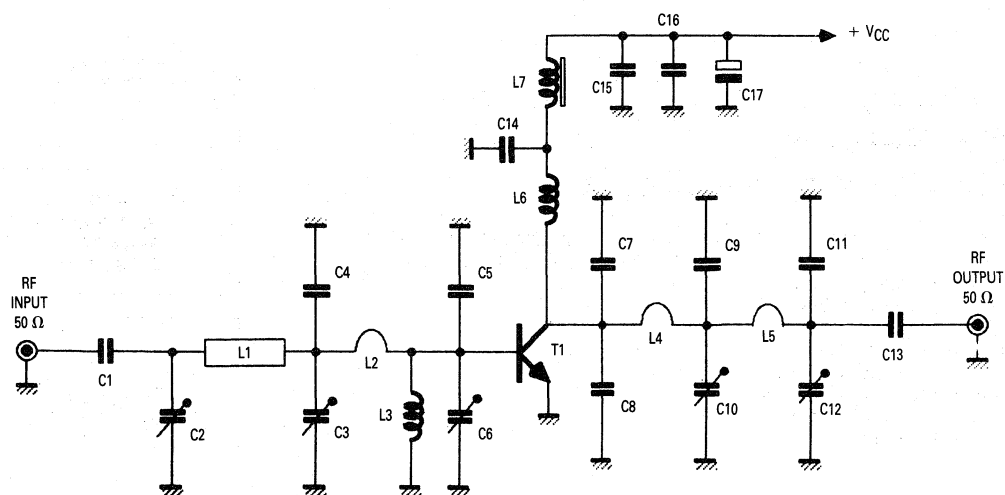


Figure 6. Output Power versus Input Power



$V_{CC} = 12.5 \text{ V}$
 $f = 440 \text{ MHz}$

C1-C13 — Capacitor 1 nF UNELCO
 C2-C10 — Capacitor 1.5–20 pF ARCO 402
 C3 — Capacitor 4–40 pF ARCO 403
 C4 — Capacitor 25 pF UNELCO
 C5-C6 — Capacitor 47 pF UNELCO
 C7-C8 — Capacitor 40 pF UNELCO
 C9 — Capacitor 10 pF UNELCO
 C11 — Capacitor 5 pF UNELCO
 C12 — Capacitor 1–7 pF ARCO 400
 C14-C15 — Capacitor 1 nF UNELCO

C16 — Capacitor Ceramic 0.1 μF
 C17 — Capacitor Electrolytic 47 μF 40 V
 L1 — Coaxial Cable 25 Ω L = 110 mm
 L2 — Copper Strip 12 x 6 mm Th: 50 μm
 L3 — Molded Inductor 4.7 μH
 L4 — Copper Strip 8 x 6 Th: 50 μm
 L5 — Air Spin 12 mm \varnothing 1 mm
 L6 — 2 Turns on ID 6 mm/1 mm core
 L7 — 5 Turns Around Ferrite Bead
 T1 — RF Transistor JO2017

Figure 7. 440 MHz Test Circuit

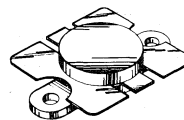
The RF Line
NPN Silicon
UHF Power Transistor

... designed primarily for 12.5 Volt wideband, large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics:
 Output Power — 37 Watts
 Gain — 4.9 dB, Min
 Efficiency — 60%, Typ
- Internally Matched for Broadband Operation
- Tested for Load Mismatch Stress
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

JO3037

37 W — 512 MHz
RF POWER
TRANSISTOR
NPN SILICON



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	83 0.48	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.1	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	10	—	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	200	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{in} = 12\text{ W}$, $f = 470\text{ MHz}$)	G_{PE}	4.9	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 37\text{ W}$, $f = 470\text{ MHz}$)	η_c	—	60	—	%
Load Mismatch ($V_{CE} = 15.5\text{ V}$, $P_{in} = 12\text{ W}$, $f = 470\text{ MHz}$, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

The RF Line

NPN Silicon
UHF Power Transistors

... designed for 24 Volt UHF large-signal applications in industrial and commercial FM equipment operating at frequencies to 960 MHz.

- Specified 24 Volt, 960 MHz Characteristics:

	PTE801	JO3501	JO3502
Output Power	2 W	15 W	35 W
Gain, Min	9 dB	9.2 dB	7.7 dB
Efficiency	45%	55%	55%
Configuration	C.E.	C.B.	C.B.

- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MAXIMUM RATINGS

Rating	Symbol	PTE801	JO3501	JO3502	Unit
Collector-Emitter Voltage	V_{CEO}	30	20	20	Vdc
Collector-Base Voltage	V_{CES}	55	50	50	Vdc
Emitter-Base Voltage	V_{EBO}	4			Vdc
Collector Current — Continuous	I_C	0.75	2	4	Adc
Operating Junction Temperature	T_J	200			°C
Storage Temperature Range	T_{stg}	-65 to +150			°C

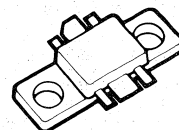
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	22	4.6	2.3	°C/W

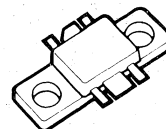
JO3501
JO3502
PTE801

2 W, 15 W, 35 W
 960 MHz
 UHF POWER
 TRANSISTORS
 NPN SILICON

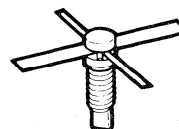
2



EA
 CASE 828-01, STYLE 1
 JO3501



EB
 CASE 319C-01, STYLE 1
 JO3502



.200 SOE
 CASE 305B-01, STYLE 1
 PTE801

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
Collector-Emitter Breakdown Voltage ($I_C = 5 \text{ mA}$, $I_B = 0$) ($I_C = 5 \text{ mA}$, $I_B = 0$) ($I_C = 25 \text{ mA}$, $I_B = 0$)	PTE801 JO3501 JO3502	$V_{(BR)CEO}$	30 20 20	— — —	— — —	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5 \text{ mA}$, $V_{BE} = 0$) ($I_C = 25 \text{ mA}$, $V_{BE} = 0$) ($I_C = 25 \text{ mA}$, $V_{BE} = 0$)	PTE801 JO3501 JO3502	$V_{(BR)CES}$	55 50 50	— — —	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1 \text{ mA}$, $I_C = 0$) ($I_E = 5 \text{ mA}$, $I_C = 0$) ($I_E = 5 \text{ mA}$, $I_C = 0$)	PTE801 JO3501 JO3502	$V_{(BR)EBO}$	4 4 4	— — —	— — —	Vdc
Collector Cutoff Current ($V_{CE} = 25 \text{ V}$, $V_{BE} = 0$)	PTE801 JO3501 JO3502	I_{CES}	— — —	— — —	2 5 10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100 \text{ mA}$, $V_{CE} = 5 \text{ V}$) ($I_C = 1 \text{ A}$, $V_{CE} = 5 \text{ V}$) ($I_C = 1 \text{ A}$, $V_{CE} = 5 \text{ V}$)	PTE801 JO3501 JO3502	h_{FE}	10 10 10	— — —	150 100 100	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 24 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 960 \text{ MHz}$)	PTE801	G_{PE}	9	—	—	dB
Common-Base Amplifier Power Gain ($V_{CE} = 24 \text{ V}$, $P_{out} = 15 \text{ W}$, $f = 960 \text{ MHz}$) ($V_{CE} = 24 \text{ V}$, $P_{out} = 35 \text{ W}$, $f = 960 \text{ MHz}$)	JO3501 JO3502	G_{PB}	9.2 7.7	— —	— —	dB
Collector Efficiency ($V_{CE} = 24 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 960 \text{ MHz}$) ($V_{CE} = 24 \text{ V}$, $P_{out} = 15 \text{ W}$, $f = 960 \text{ MHz}$) ($V_{CE} = 24 \text{ V}$, $P_{out} = 35 \text{ W}$, $f = 960 \text{ MHz}$)	PTE801 JO3501 JO3502	η	45 55 55	— — —	— — —	%

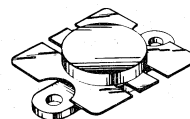
The RF Line
NPN Silicon
VHF Power Transistor

... designed primarily for 12.5 Volt wideband, large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics:
Output Power — 36 Watts
Gain — 7.8 dB, Min
- Internally Matched for Broadband Operation
- Tested for Load Mismatch Stress
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

JO4036

36 W — 175 MHz
RF POWER
TRANSISTOR
NPN SILICON



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	6.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	100 0.57	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{in} = 6\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	7.8	—	—	dB
Load Mismatch ($V_{CE} = 15.5\text{ V}$, $P_{in} = 6\text{ W}$, $f = 175\text{ MHz}$, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Return Loss ($V_{CE} = 12.5\text{ V}$, $P_{in} = 6\text{ W}$, $f = 175\text{ MHz}$, Circuit in Figure 7)	IRL	10	—	—	dB

TYPICAL CHARACTERISTICS

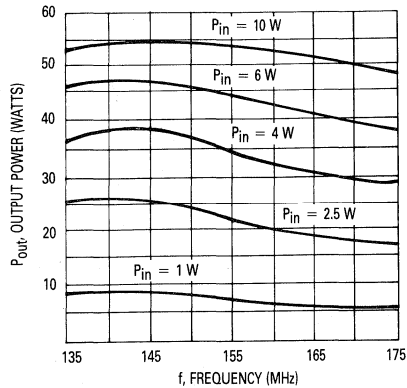


Figure 1. Output Power versus Frequency

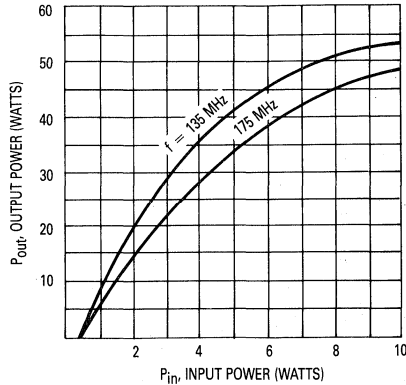


Figure 2. Output Power versus Input Power

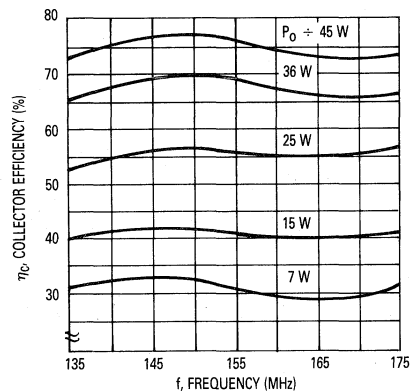


Figure 3. Collector Efficiency versus Frequency

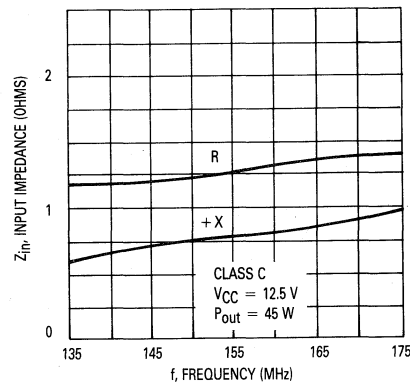


Figure 4. Series Input Impedance versus Frequency

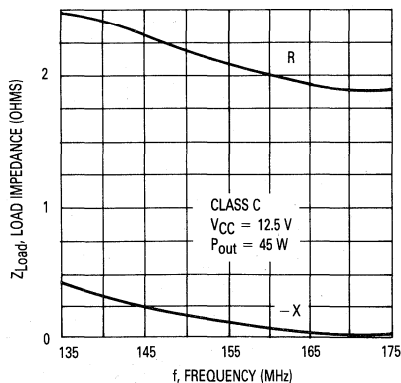


Figure 5. Series Load Impedance versus Frequency

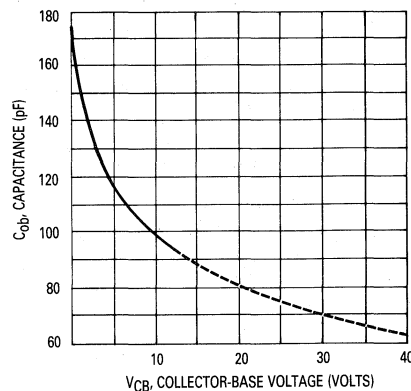


Figure 6. Output Capacitance versus Voltage

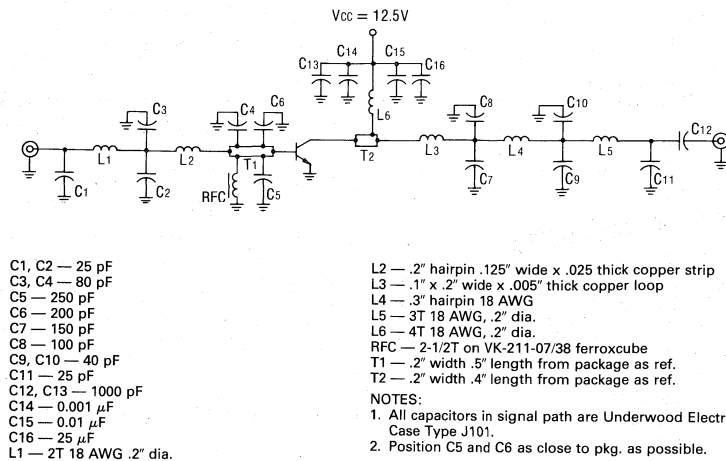


Figure 7. Broadband Test Fixture

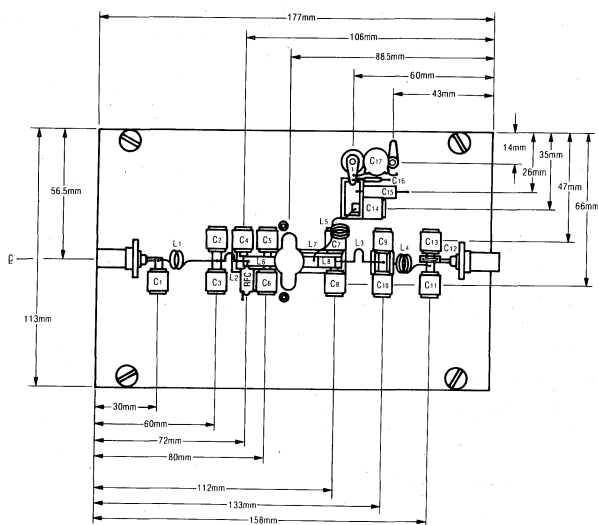


Figure 8. Test Fixture Component Layout

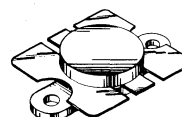
The RF Line
NPN Silicon
VHF Power Transistor

... designed primarily for 12.5 Volt wideband, large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics:
Output Power — 45 Watts
Gain — 6.5 dB, Min
- Internally Matched for Broadband Operation
- Tested for Load Mismatch Stress
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

JO4045

45 W — 175 MHz
RF POWER
TRANSISTOR
NPN SILICON



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CES}	36	Vdc
Collector Current — Continuous	I_C	6.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	100 0.57	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	200	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{in} = 10\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	6.5	—	—	dB
Load Mismatch ($V_{CE} = 15.5\text{ V}$, $P_{in} = 10\text{ W}$, $f = 175\text{ MHz}$, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Return Loss ($V_{CE} = 12.5\text{ V}$, $P_{in} = 10\text{ W}$, $f = 175\text{ MHz}$, Circuit in Figure 7)	IRL	10	—	—	dB

TYPICAL CHARACTERISTICS

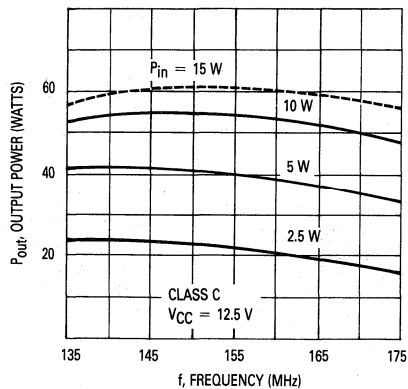


Figure 1. Output Power versus Frequency

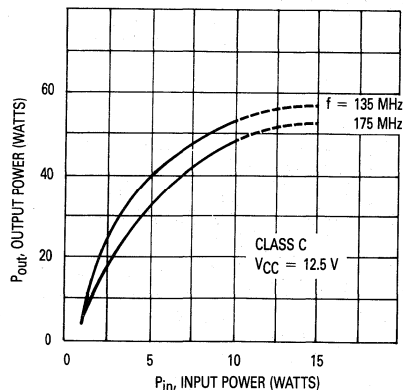


Figure 2. Output Power versus Input Power

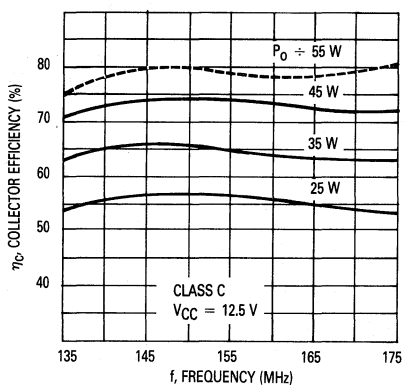


Figure 3. Broadband Collector Efficiency

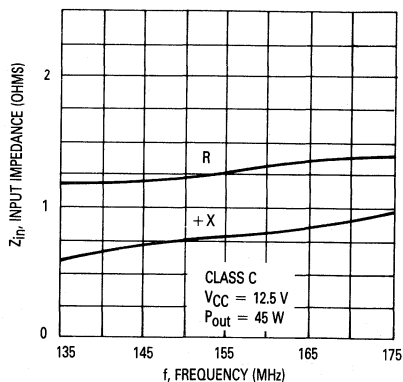


Figure 4. Series Input Impedance

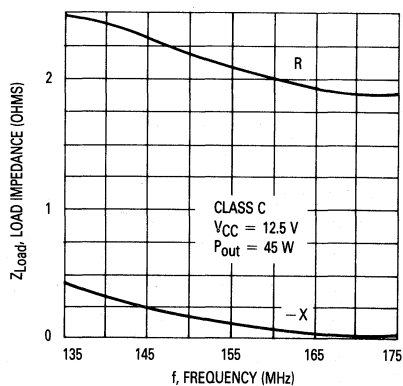


Figure 5. Series Load Impedance

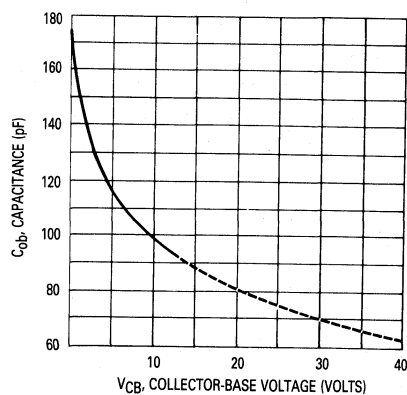
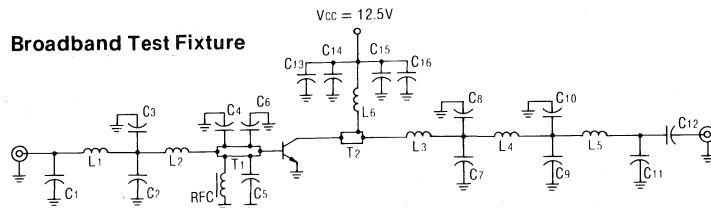


Figure 6. Output Capacitance

Broadband Test Fixture



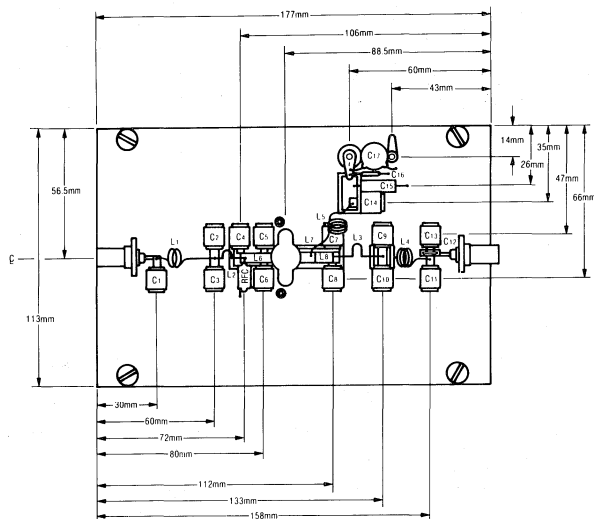
C1, C2 — 25 pF
 C3, C4 — 80 pF
 C5 — 250 pF
 C6 — 200 pF
 C7 — 150 pF
 C8 — 100 pF
 C9, C10 — 40 pF
 C11 — 25 pF
 C12, C13 — 1000 pF
 C14 — 0.001 μ F
 C15 — 0.01 μ F
 C16 — 25 μ F
 L1 — 2T 18 AWG .2" dia.

L2 — .2" hairpin .125" wide x .025 thick copper strip
 L3 — .1" x .2" wide x .005" thick copper loop
 L4 — .3" hairpin 18 AWG
 L5 — 3T 18 AWG, .2" dia.
 L6 — 4T 18 AWG, .2" dia.
 RFC — 2-1/2T on VK-211-07/38 ferroxcube
 T1 — .2" width .5" length from package as ref.
 T2 — .2" width .4" length from package as ref.

NOTES:

1. All capacitors in signal path are Underwood Electric Corp. Case Type J101.
2. Position C5 and C6 as close to pkg. as possible.

Figure 7. Broadband Test Fixture



C1 — 25 pF
 C2, C4 — 80 pF
 C3 — 30 pF
 C5 — 250 pF
 C6 — 200 pF
 C7 — 150 pF
 C8 — 100 pF
 C9, C10 — 40 pF
 C11 — 10 pF
 C12, C14 — 1000 pF
 C13 — 15 pF
 C15 — 5 μ F 25 V

C16 — 0.001K Disc
 C17 — 0.01 μ 1KV Disc
 L1 — 2T .2" dia. 18 AWG .250" long
 L2 — .2" hairpin .125" wide x .025 thick
 RFC1 — 2-1/2T on VK-211-07/38 ferroxcube
 L3 — .3" hairpin #18 AWG
 L4 — 3T .2" dia. #10 AWG .500" long
 L5 — 4T .2" dia. #18 AWG .400" long
 L6 — .5" x .2"
 L7 — .4" x .2"
 L8 — .1" x .2" wide x .005" thick
 Material: .062" Epoxy Board, Copper Clad — 2 Sides

Figure 8. Test Fixture Component Layout

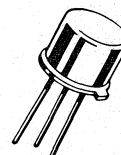
The RF Line **NPN Silicon** **High Frequency Transistor**

... designed for ultra-linear communications or instrumentation applications. Low noise figure combined with high-output capability gives this device an exceptional dynamic range. Gold metallization and diffused emitter ballasting are combined to achieve the high reliability demanded by the most severe communications requirements. High gain makes this transistor ideal for broadband applications.

- Low Noise — 2.5 dB Typ @ $f = 300$ MHz
- High Gain — $|S_{21}|^2$ Typ = 13.5 dB @ $f = 300$ MHz
- Low Distortion — ITO = 45 dBm Typ @ $f = 300$ MHz
- Gold Metallization
- Diffused Ballast Resistors

LT1001A

$I_C = 200$ mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



TO-39
CASE 79-04, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.2	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	- 65 to + 200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5$ mA, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	50	—	μ Adc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mA, $I_B = 5$ mA)	$V_{CE(sat)}$	—	500	—	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 10$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	1.6	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum ($V_{CE} = 8\text{ V}$, $I_C = 50\text{ mA}$, $f = 300\text{ MHz}$)	NF _{MIN}	—	2.5	—	dB
Cutoff Frequency ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$)	f_T	—	3	—	GHz
Maximum Unilateral Gain ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 300\text{ MHz}$)	$G_{U\text{MAX}}$	—	15	—	dB
Insertion Gain ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 300\text{ MHz}$)	$|S_{21}|^2$	—	13.5	—	dB
Output Power @ 1 dB Compression ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 300\text{ MHz}$)	P _{o1} dB	—	26	—	dBm
Third Order Intercept ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 300\text{ MHz}$)	ITO	—	45	—	dBm

TYPICAL CHARACTERISTICS

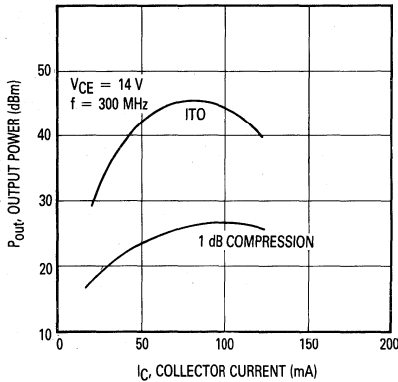


Figure 1. Third Order Intercept and 1 dB Compression versus Current

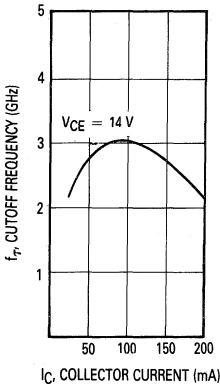


Figure 2. Gain-Bandwidth Product versus Collector Current

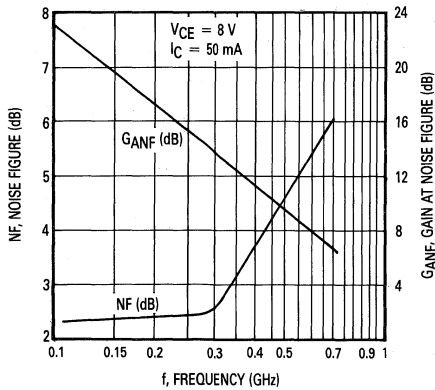


Figure 3. Noise Figure and Associated Gain versus Frequency

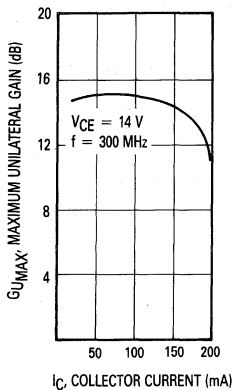


Figure 4. $G_{U\text{MAX}}$ versus Collector Current

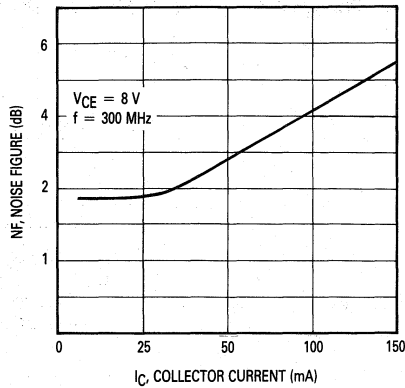


Figure 5. Noise Figure versus Collector Current

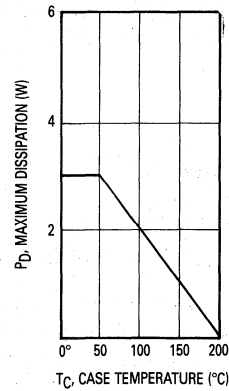


Figure 6. Dissipation versus Temperature

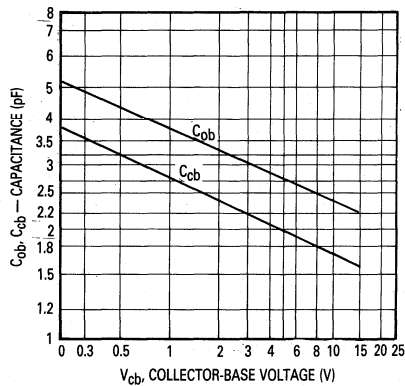


Figure 7. Junction Capacitance versus Voltage

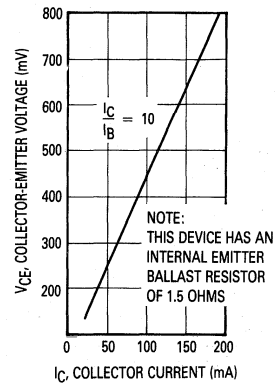


Figure 8. Collector Saturation Characteristics

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂		k
V _{CE} = 8 V, I _C = 50 mA									
100	-7.23	-131.8	21.95	101.3	-25.33	58.8	-7.08	-78.4	0.631
200	-9.06	-167.6	16.02	85.4	-21.46	65.6	-11.85	-86.2	0.969
300	-9.06	175.3	12.69	75.7	-18.49	68.9	-12.58	-93.5	1.025
400	-8.90	160.9	10.33	67.5	-16.21	69.7	-12.74	-102.7	1.049
500	-8.87	145.8	8.53	60.8	-14.42	69.7	-12.55	-110.4	1.071
600	-8.67	136.0	7.14	54.8	-12.90	69.3	-11.66	-119.7	0.068
700	-8.70	124.0	6.12	49.6	-11.50	68.3	-10.72	-126.6	1.059
800	-8.94	114.2	5.13	43.7	-10.37	66.4	-9.85	-136.3	1.065
900	-8.91	105.3	4.28	39.1	-9.34	65.0	-9.39	-143.9	1.066
1000	-9.16	93.6	3.63	34.6	-8.42	62.8	-3.70	-152.1	1.064
V _{CE} = 14 V, I _C = 90 mA									
100	-7.74	-126.6	22.66	103.0	-28.85	57.6	-6.82	-47.5	0.748
200	-8.33	-157.8	17.08	86.3	-25.01	62.6	-8.40	-56.7	0.965
300	-8.28	-172.6	13.71	75.6	-22.37	65.8	-8.25	-66.4	1.026
400	-8.31	-177.5	11.25	66.7	-20.31	66.9	-7.58	-75.0	1.037
500	-8.18	173.9	9.61	61.2	-17.69	70.4	-7.33	-78.9	0.938
600	-8.12	167.5	8.08	55.5	-16.35	71.2	-6.81	-85.1	0.932
700	-8.19	161.2	6.83	48.9	-15.21	70.2	-6.22	-91.6	0.913
800	-8.16	-155.6	5.60	43.6	-14.22	70.9	-5.44	-96.4	0.883
900	-8.07	149.9	4.58	38.0	-13.28	70.0	-4.84	-102.4	0.844
1000	-7.86	143.8	3.70	34.4	-12.40	70.2	-4.54	-105.1	0.824

Figure 9. Common Emitter S-Parameters

The RF Line **NPN Silicon** **High Frequency Transistor**

... specifically designed for CRT driver applications requiring high frequency and high voltage, such as high resolution color graphics video monitors.

- High Voltage — $V_{(BR)CBO} = 100$ V Min
- High Cutoff Frequency — $f_T = 900$ MHz Min
- Low Output Capacitance — $C_{cb} = 2.5$ pF Max @ $V_{CB} = 15$ V
- Gold Metallization

LT1739

$f_T = 900$ MHz MIN
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



TO-39
CASE 79-04, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	300	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Base Breakdown Voltage ($I_C = 0.1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 1$ mA, $R_{BE} = 1$ k)	$V_{(BR)CER}$	100	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 70$ V, $I_E = 0$)	I_{CBO}	—	—	20	μ Adc
Collector Cutoff Current ($V_{CE} = 70$ V, $V_{BE} = 0$)	I_{CES}	—	—	100	μ Adc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mA, $I_B = 5$ mA)	$V_{CE(sat)}$	—	—	900	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 15$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	2.5	pF
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FUNCTIONAL TESTS

Cutoff Frequency ($V_{CE} = 15$ V, $I_C = 50$ mA, $f = 250$ MHz)	f_T	900	—	—	MHz
Insertion Gain ($V_{CE} = 10$ V, $I_C = 50$ mA, $f = 200$ MHz)	$ S_{21} ^2$	12	—	—	dB

TYPICAL CHARACTERISTICS

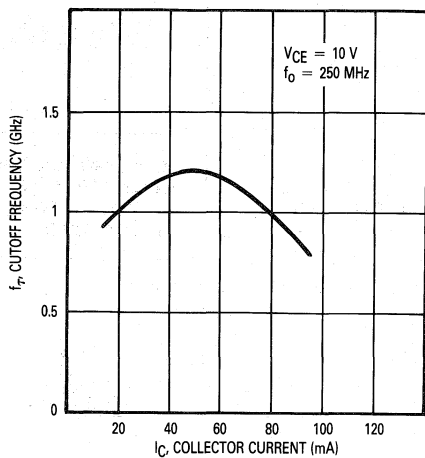


Figure 1. Gain Bandwidth Product versus Collector Current

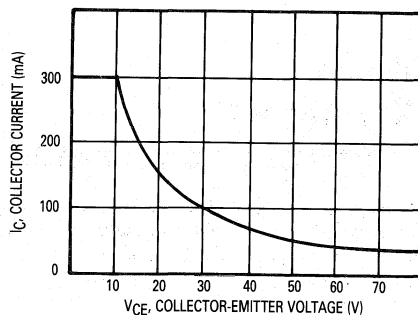


Figure 2. Safe Operating Area

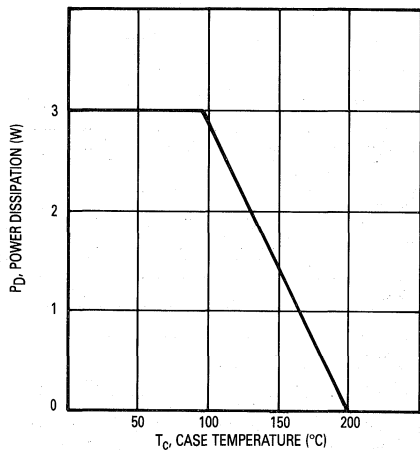


Figure 3. Power Dissipation versus Temperature

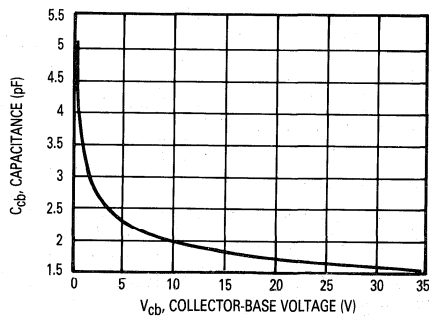


Figure 4. Junction Capacitance versus Voltage

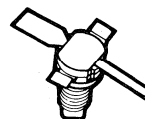
The RF Line
NPN Silicon
High Frequency Transistor

... specifically designed for CRT driver applications requiring high voltage and high frequency, such as high resolution color graphics video monitors.

- High Voltage — $V_{(BR)CEO} = 120 \text{ V Min}$
- High Cutoff Frequency — $f_T = 1000 \text{ MHz Min}$
- Low Output Capacitance — $C_{cb} = 2.5 \text{ pF Max @ } V_{CB} = 15 \text{ V}$
- Gold Metallization
- Hermetic SOE Package

LT1814

$f_T = 1000 \text{ MHz MIN}$
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



GP-14
CASE 401-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	400	mA
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mA}, I_E = 0$)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}, I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 80 \text{ V}, V_{BE} = 0$)	I_{CES}	—	—	100	μA
Collector Cutoff Current ($V_{CB} = 80 \text{ V}, I_E = 0$)	I_{CBO}	—	—	20	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50 \text{ mA}, V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage ($I_C = 50 \text{ mA}, I_B = 5 \text{ mA}$)	$V_{CE(sat)}$	—	—	800	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 15 \text{ V}, I_E = 0, f = 1 \text{ MHz}$)	C_{ob}	—	—	4	pF
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FUNCTIONAL TESTS

Cutoff Frequency ($V_{CE} = 15 \text{ V}, I_C = 50 \text{ mA}, f = 250 \text{ MHz}$)	f_T	1	—	—	GHz
Insertion Gain ($V_{CE} = 10 \text{ V}, I_C = 50 \text{ mA}, f = 200 \text{ MHz}$)	$ S_{21} ^2$	15	—	—	dB
Maximum Oscillation Frequency ($V_{CE} = 10 \text{ V}, I_C = 80 \text{ mA}, f = 200 \text{ MHz}$)	f_{MAX}	2	—	—	GHz

TYPICAL CHARACTERISTICS

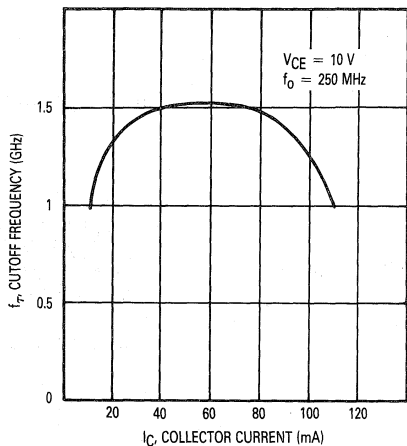


Figure 1. Gain Bandwidth Product versus Collector Current

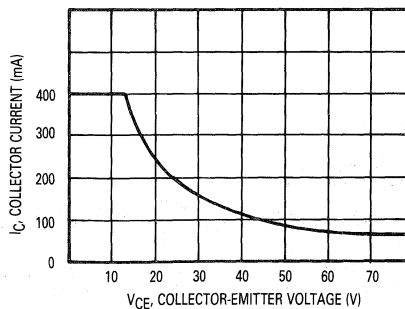


Figure 2. Safe Operating Area

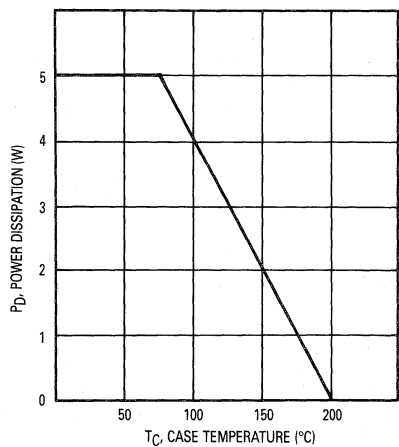


Figure 3. Power Dissipation versus Temperature

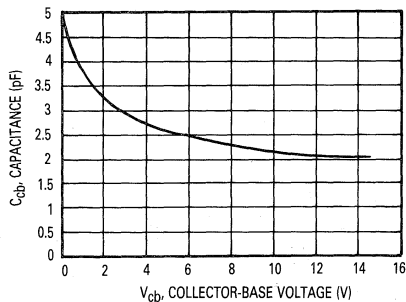


Figure 4. Junction Capacitance versus Voltage

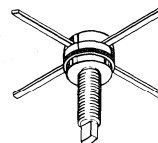
The RF Line
NPN Silicon
High Frequency Transistor

... specifically designed for CRT driver applications requiring high voltage and high frequency, such as high resolution color graphics video monitors.

- High Voltage — $V_{(BR)CBO} = 120 \text{ V Min}$
- High Cutoff Frequency — $f_T = 1000 \text{ MHz Min}$
- Low Output Capacitance — $C_{cb} = 2.5 \text{ pF Max @ } V_{CB} = 15 \text{ V}$
- Gold Metallization
- *Common Base Configuration*

LT1817

$f_T = 1000 \text{ MHz MIN}$
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



TO-117A
CASE 244D-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	70	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	400	mA
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1 \text{ mA}, I_B = 0$)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mA}, I_E = 0$)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}, I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 80 \text{ V}, I_E = 0$)	I_{CBO}	—	—	20	μA
Collector Cutoff Current ($V_{CE} = 80 \text{ V}, V_{BE} = 0$)	I_{CES}	—	—	100	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50 \text{ mA}, V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage ($I_C = 50 \text{ mA}, I_B = 5 \text{ mA}$)	$V_{CE(sat)}$	—	—	800	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 15 \text{ V}, I_E = 0, f = 1 \text{ MHz}$)	C_{ob}	—	—	2.5	pF
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FUNCTIONAL TESTS

Cutoff Frequency ($V_{CE} = 15 \text{ V}, I_C = 50 \text{ mA}, f = 200 \text{ MHz}$)	f_T	1	—	—	GHz
Insertion Gain ($V_{CE} = 10 \text{ V}, I_C = 50 \text{ mA}, f = 200 \text{ MHz}$)	$ S_{21} ^2$	15	—	—	dB

TYPICAL CHARACTERISTICS

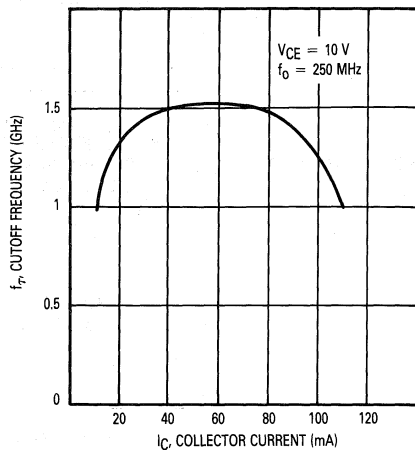


Figure 1. Gain Bandwidth Product versus Collector Current

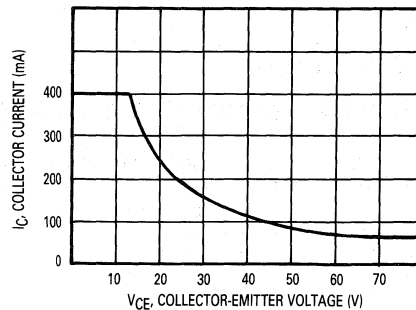


Figure 2. Safe Operating Area

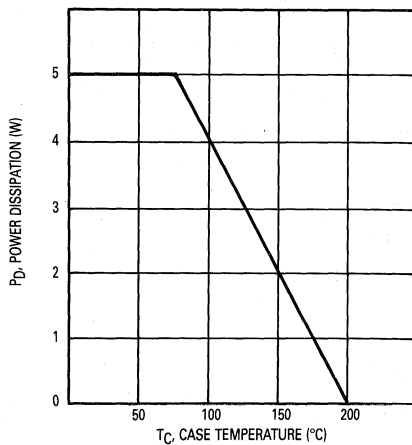


Figure 3. Power Dissipation versus Temperature

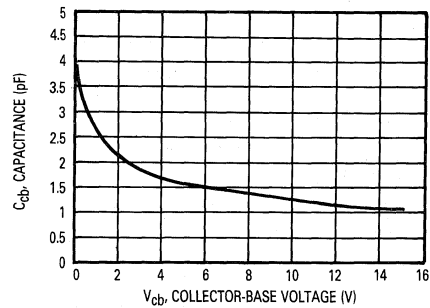


Figure 4. Junction Capacitance versus Voltage

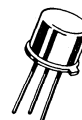
The RF Line
NPN Silicon
High Frequency Transistor

... specifically designed for CRT driver applications requiring high frequency and high voltage, such as high resolution color graphics video monitors.

- High Voltage — $V_{(BR)CBO} = 120 \text{ V Min}$
- High Cutoff Frequency — $f_T = 1000 \text{ MHz Min}$
- Low Output Capacitance — $C_{cb} = 2.5 \text{ pF Max @ } V_{CB} = 15 \text{ V}$
- Gold Metallization

LT1839

$f_T = 1000 \text{ MHz MIN}$
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



TO-39
CASE 79-04, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	70	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	300	mA
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1 \text{ mA}, I_B = 0$)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mA}, I_E = 0$)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}, I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 80 \text{ V}, I_E = 0$)	I_{CBO}	—	—	20	μA
Collector Cutoff Current ($V_{CE} = 80 \text{ V}, V_{BE} = 0$)	I_{CES}	—	—	100	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50 \text{ mA}, V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage ($I_C = 50 \text{ mA}, I_B = 5 \text{ mA}$)	$V_{CE(sat)}$	—	—	800	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 15 \text{ V}, I_E = 0, f = 1 \text{ MHz}$)	C_{cb}	—	—	2	pF
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FUNCTIONAL TESTS

Cutoff Frequency ($V_{CE} = 10 \text{ V}, I_C = 80 \text{ mA}, f = 250 \text{ MHz}$)	f_T	1	—	—	GHz
Insertion Gain ($V_{CE} = 10 \text{ V}, I_C = 50 \text{ mA}, f = 200 \text{ MHz}$)	$ S_{21} ^2$	13	—	—	dB

TYPICAL CHARACTERISTICS

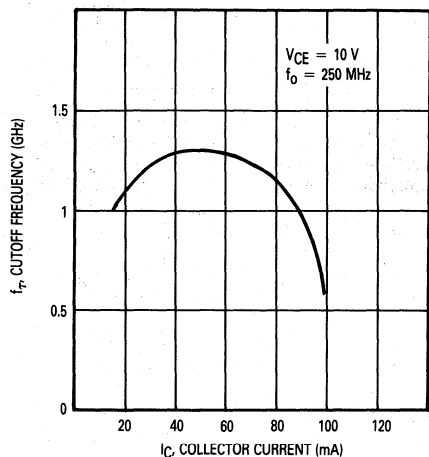


Figure 1. Gain Bandwidth Product versus Collector Current

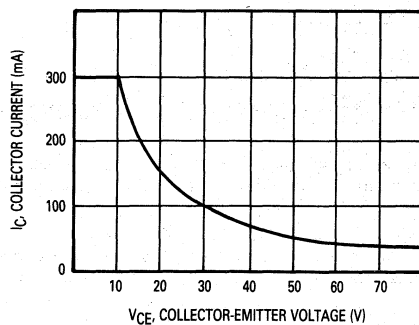


Figure 2. Safe Operating Area

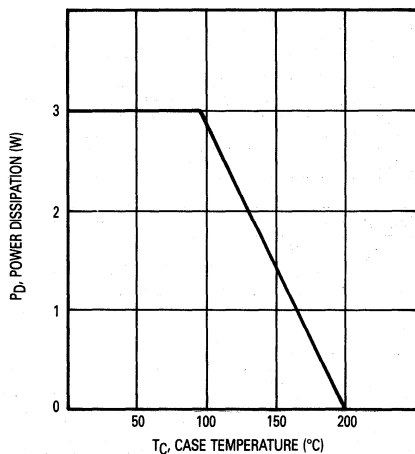


Figure 3. Power Dissipation versus Temperature

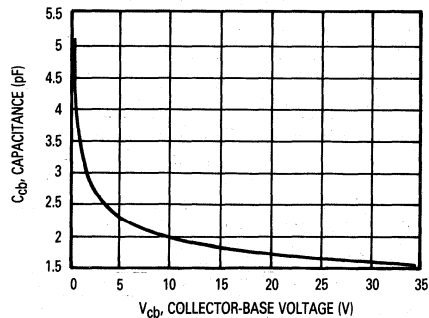


Figure 4. Junction Capacitance versus Voltage

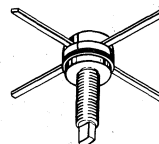
The RF Line
NPN Silicon
High Frequency Transistor

... designed for ultra-linear communications or instrumentation applications. Low noise figure combined with high-output capability gives this device an exceptional dynamic range.

- Low Noise — 2.5 dB Typ @ $f = 300$ MHz
- High Output — P_{o1} dB = 26 dBm Typ @ $f = 500$ MHz
- Low Distortion — $ITO_{typ} = 46$ dBm @ $f = 500$ MHz

LT2001

$I_C = 200$ mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



TO-117A
CASE 244A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	200	mA
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5$ mA, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	50	—	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mA, $I_C/I_B = 10$)	$V_{CE(sat)}$	—	500	—	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 10$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	1.2	—	pF
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FUNCTIONAL TESTS

Noise Figure, Minimum ($V_{CE} = 8$ V, $I_C = 50$ mA, $f = 300$ MHz)	NF_{MIN}	—	2.5	—	dB
Cutoff Frequency ($V_{CE} = 14$ V, $I_C = 90$ mA)	f_r	—	3	—	GHz
Maximum Unilateral Gain ($V_{CE} = 14$ V, $I_C = 90$ mA, $f = 500$ MHz)	GU_{MAX}	—	14	—	dB
Insertion Gain ($V_{CE} = 14$ V, $I_C = 90$ mA, $f = 500$ MHz)	$|S_{21}|^2$	—	11.5	—	dB
Output Power @ 1 dB Compression ($V_{CE} = 14$ V, $I_C = 90$ mA, $f = 500$ MHz)	P_{o1} dB	—	26	—	dBm
Third Order Intercept ($V_{CE} = 14$ V, $I_C = 90$ mA, $f = 500$ MHz)	ITO	—	46	—	dBm

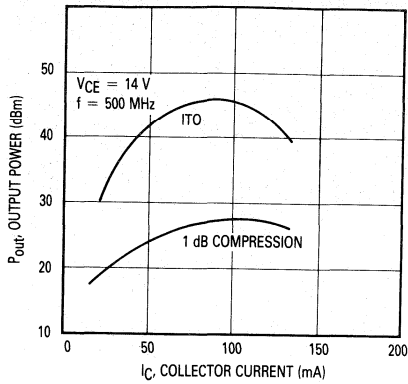


Figure 1. Third Order Intercept and 1 dB Compression versus Current

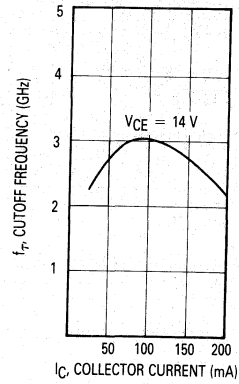


Figure 2. Gain-Bandwidth Product versus Collector Current

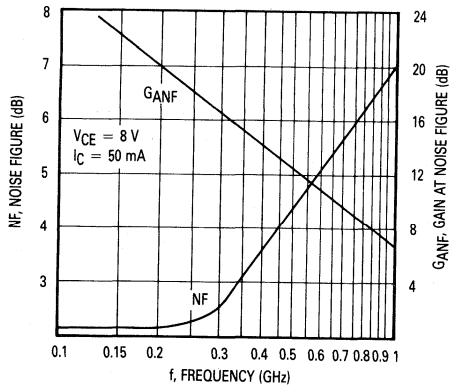


Figure 3. Noise Figure and Associated Gain versus Frequency

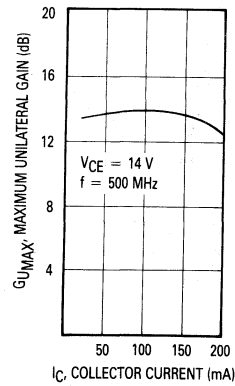


Figure 4. G_{UMAX} versus Collector Current

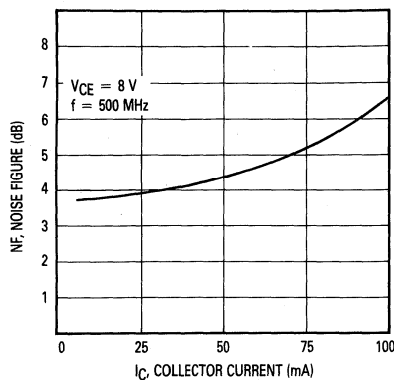


Figure 5. Noise Figure versus Collector Current

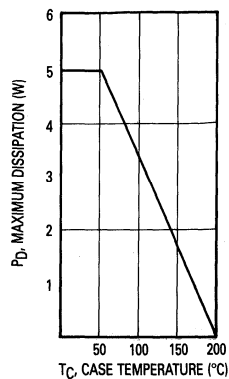


Figure 6. Dissipation versus Temperature

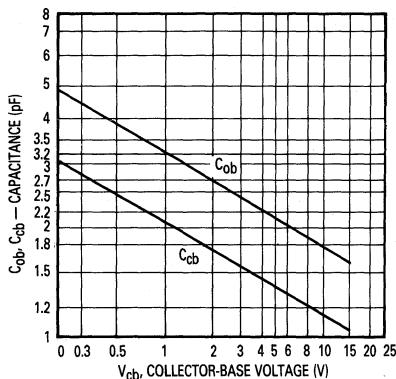


Figure 7. Junction Capacitance versus Voltage

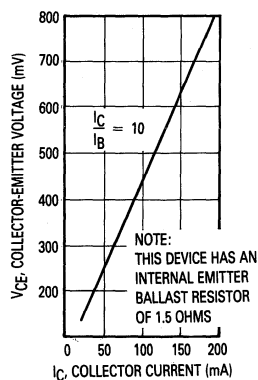


Figure 8. Collector Saturation Voltage versus Current

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂		k
VCE = 8 V, IC = 50 mA									
100	-6.12	-118.9	23.57	114.3	-29.61	52.8	-6.47	-57.0	0.611
200	-7.31	-159.1	19.20	95.9	-26.38	58.5	-9.68	-58.3	0.910
300	-7.46	177.3	16.11	82.7	-23.77	62.1	-10.29	-70.7	1.003
400	-7.48	164.7	13.77	73.2	-21.67	64.7	-10.21	-75.8	1.038
500	-7.47	151.5	11.84	64.7	-20.05	65.4	-9.57	-86.8	1.075
600	-6.93	141.2	10.35	56.8	-18.43	65.3	-9.85	-98.4	1.076
700	-7.07	134.5	9.04	50.9	-17.10	65.2	-9.23	-105.6	1.085
800	-6.69	126.1	7.96	42.8	-15.98	63.3	-8.34	-126.4	1.093
900	-6.33	118.3	6.88	36.4	-14.92	61.6	-8.17	-136.4	1.101
1000	-6.32	113.6	5.93	30.6	-13.96	60.3	-7.96	-145.1	1.114
VCE = 14 V, IC = 90 mA									
100	-5.91	-131.6	24.75	110.5	-32.25	55.4	-5.79	-36.7	0.626
200	-6.13	-162.8	19.32	95.5	-28.89	65.0	-7.94	-39.1	0.918
300	-5.90	-176.7	16.04	88.0	-26.35	73.3	-8.65	-43.2	1.030
400	-5.66	173.8	13.56	82.7	-24.29	79.2	-8.88	-50.2	1.089
500	-6.19	170.6	11.80	60.4	-21.99	66.6	-8.11	-60.9	1.008
600	-5.91	165.5	10.29	51.3	-20.30	64.8	-7.84	-69.2	0.947
700	-5.72	161.2	8.87	43.9	-19.06	64.1	-7.60	-78.8	0.938
800	-5.57	157.8	7.75	36.3	-17.97	62.2	-7.34	-87.1	0.909
900	-5.41	154.5	6.79	29.5	-16.52	60.1	-6.63	-94.4	0.800
1000	-5.38	150.9	5.82	22.0	-15.71	57.7	-6.58	-103.5	0.811

Figure 9. Common Emitter S-Parameters

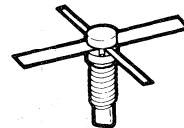
The RF Line
NPN Silicon
High Frequency Transistor

... designed for ultra-linear communications or instrumentation applications. Low noise figure combined with high-output capability gives this device an exceptional dynamic range. Gold metallization and diffused emitter ballasting are combined to achieve the high reliability demanded by the most severe communications requirements. High gain makes this transistor ideal for broadband applications.

- Low Noise — 2.5 dB Typ @ $f = 300$ MHz
- High Gain — $|S_{21}|^2 = 14$ dB Typ @ $f = 500$ MHz
- High Output — P_{O1} dB = 26 dBm Typ @ $f = 500$ MHz
- Gold Metallization
- Diffused Ballast Resistors

LT3005

$I_C = 200$ mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



.200 SOE
CASE 305B-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5$ mA, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	50	—	μ Adc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage ($I_C = 100$ mA, $I_C/I_B = 10$)	$V_{CE(sat)}$	—	500	—	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 10$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	1.1	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum ($V_{CE} = 8\text{ V}$, $I_C = 50\text{ mA}$, $f = 300\text{ MHz}$)	NF _{MIN}	—	2.5	—	dB
Cutoff Frequency ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$)	f_T	—	3	—	GHz
Maximum Unilateral Gain ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	GU _{MAX}	—	18	—	dB
Insertion Gain ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	$|S_{21}|^2$	—	14	—	dB
Output Power @ 1 dB Compression ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	P _{o1} dB	—	26	—	dBm
Third Order Intercept ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	ITO	—	46	—	dBm
Maximum Oscillation Frequency ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$)	f _{MAX}	—	4	—	GHz

TYPICAL CHARACTERISTICS

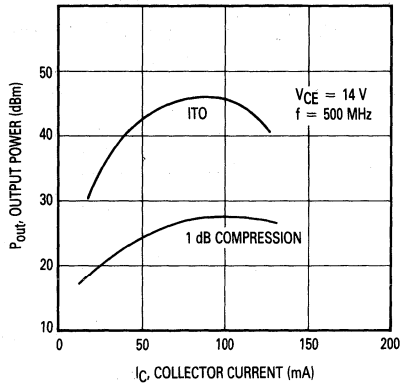


Figure 1. Third Order Intercept and 1 dB Compression versus Current

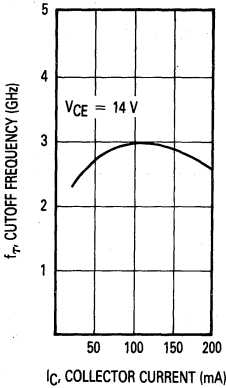


Figure 2. Gain-Bandwidth Product versus Collector Current

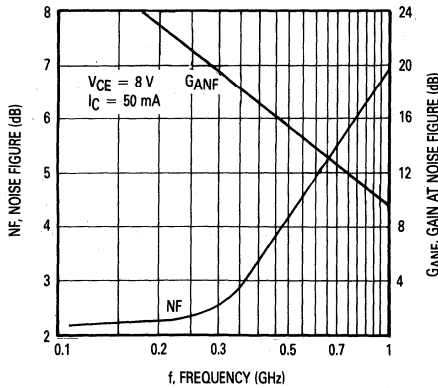


Figure 3. Noise Figure and Associated Gain versus Frequency

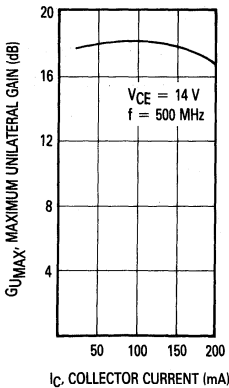


Figure 4. GU_{MAX} versus Collector Current

TYPICAL CHARACTERISTICS

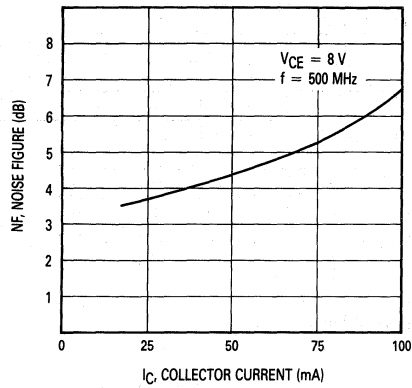


Figure 5. Noise Figure versus Collector Current

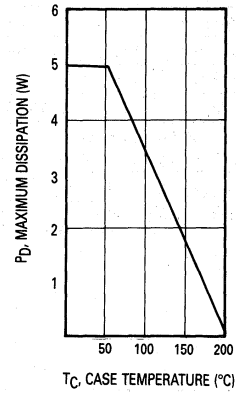


Figure 6. Dissipation versus Temperature

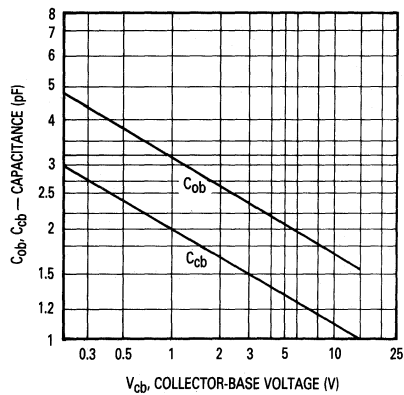


Figure 7. Junction Capacitance versus Voltage

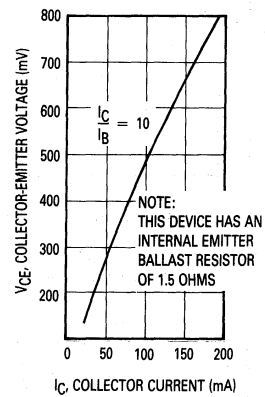


Figure 8. Collector Saturation Characteristics

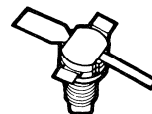
The RF Line
NPN Silicon
High Frequency Transistor

... designed for ultra-linear communications or instrumentation applications. Low noise figure combined with high-output capability gives this device an exceptional dynamic range. Gold metallization and diffused emitter ballasting are combined to achieve the high reliability demanded by the most severe communications requirements. High gain makes this transistor ideal for broadband applications. In addition, the LT3014 is hermetic, making it suitable for high reliability applications.

- High Gain — $|S_{21}|^2 = 14$ dB Typ @ $f = 500$ MHz
- Low Distortion — $1TO = 45$ dBm Typ
- High Output — P_{O1} dB = 26 dBm Typ @ $f = 500$ MHz
- Hermetic Package
- Gold Metallization
- Diffused Ballast Resistors

LT3014

$I_C = 200$ mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



GP-14 S
CASE 401-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5$ mA, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	50	—	μ Adc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mA, $I_C/I_B = 10$)	$V_{CE(sat)}$	—	500	—	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 10$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	1.1	—	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum ($V_{CE} = 8\text{ V}$, $I_C = 50\text{ mA}$, $f = 300\text{ MHz}$)	NF _{MIN}	—	3.1	—	dB
Cutoff Frequency ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$)	f_T	—	3	—	GHz
Maximum Unilateral Gain ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	$G_{U\text{MAX}}$	—	19	—	dB
Insertion Gain ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	$|S_{21}|^2$	—	14	—	dB
Output Power @ 1 dB Compression ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	$P_{O1\text{ dB}}$	—	26	—	dBm
Third Order Intercept ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	ITO	—	46	—	dBm
Maximum Oscillation Frequency ($V_{CE} = 14\text{ V}$, $I_C = 90\text{ mA}$)	f_{MAX}	—	4.5	—	GHz

TYPICAL CHARACTERISTICS

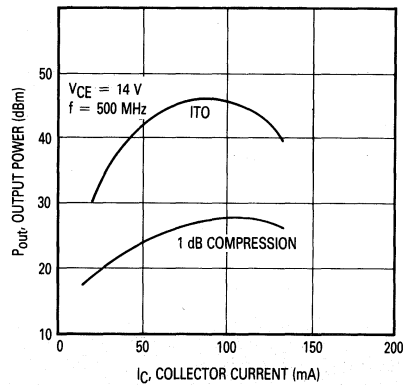


Figure 1. Third Order Intercept and 1 dB Compression versus Current

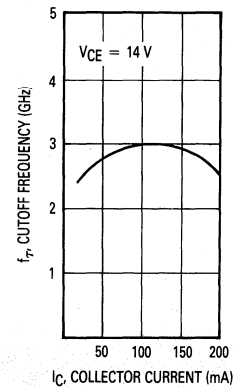


Figure 2. Gain-Bandwidth Product versus Collector Current

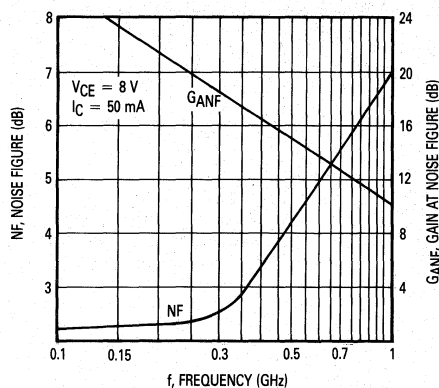
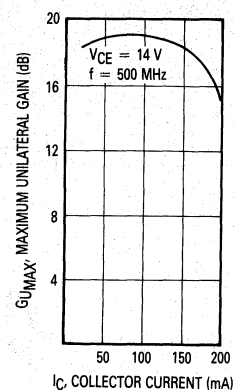


Figure 3. Noise Figure and Associated Gain versus Frequency

Figure 4. $G_{U\text{MAX}}$ versus Collector Current

TYPICAL CHARACTERISTICS

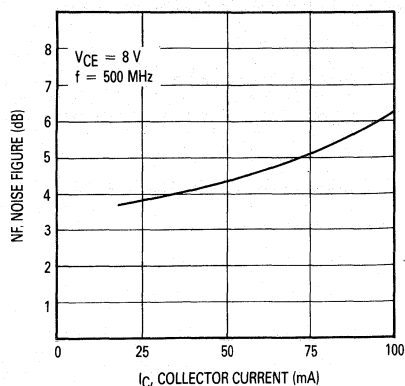


Figure 5. Noise Figure versus Collector Current

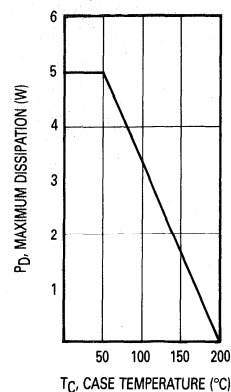


Figure 6. Dissipation versus Temperature

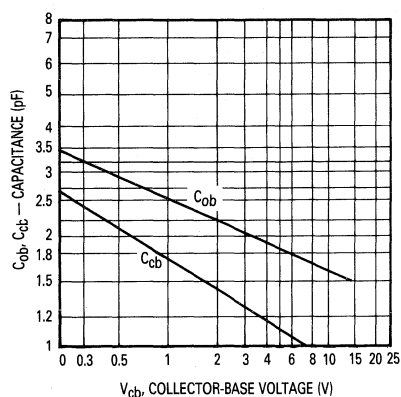


Figure 7. Junction Capacitance versus Voltage

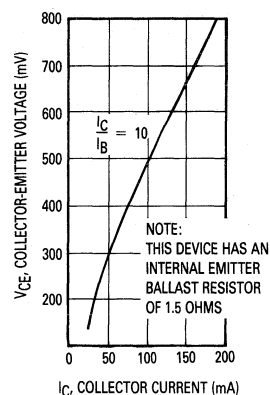


Figure 8. Collector Saturation Characteristics

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂		k
VCE = 8 V, IC = 50 mA									
100	-2.21	-123.8	26.31	115.5	-30.27	33.9	-3.67	-71.1	0.007
200	-2.40	-158.3	21.07	96.0	-29.41	24.6	-8.66	-81.7	0.391
300	-2.27	-176.3	17.87	83.7	-29.01	22.5	-9.18	-94.9	0.528
400	-2.09	172.2	15.45	74.7	-28.59	24.1	-9.22	-101.2	0.633
500	-2.08	162.5	13.38	67.0	-28.41	26.0	-8.55	-110.7	0.791
600	-1.92	153.9	11.87	59.3	-28.01	27.7	-8.49	-120.6	0.884
700	-1.88	147.1	10.51	53.7	-27.56	30.3	-7.62	-124.4	0.942
800	-1.91	139.9	9.08	45.3	-27.32	31.5	-6.86	-141.5	1.144
900	-1.99	133.8	7.91	39.2	-26.89	33.6	-6.54	-149.5	1.319
1000	-2.14	128.7	6.81	33.4	-26.45	36.6	-6.06	-154.1	1.491
VCE = 14 V, IC = 90 mA									
100	-2.41	-121.2	26.83	116.3	-32.67	35.5	-4.80	-45.9	0.205
200	-2.24	-151.3	21.78	96.3	-31.51	26.3	-7.58	-55.8	0.395
300	-2.16	-163.9	18.46	85.3	-31.02	26.0	-8.45	-62.4	0.557
400	-2.09	-171.3	15.99	77.2	-30.78	27.6	-8.36	-69.6	0.697
500	-2.12	-173.4	14.00	67.8	-29.97	21.4	-7.13	-74.8	0.739
600	-2.10	-177.5	12.33	59.6	-29.70	21.4	-6.64	-80.6	0.838
700	-2.07	-178.9	10.81	53.2	-29.48	23.3	-6.26	-87.1	0.928
800	-2.04	-176.0	9.59	46.6	-29.22	24.8	-5.87	-92.4	0.992
900	-1.97	-170.5	8.45	36.9	-28.75	25.5	-5.29	-98.7	0.949
1000	-1.98	-167.5	7.35	31.2	-28.55	26.2	-5.11	-103.8	1.058

Figure 9. Common Emitter S-Parameters

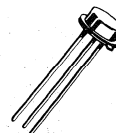
The RF Line
NPN Silicon
High Frequency Transistor

... designed for ultra-linear communications or instrumentation applications.

- Low Noise — 2.5 dB Typ @ $f = 200$ MHz
- High Gain — $|S_{21}|^2 = 15$ dB Typ @ $f = 300$ MHz
- Low Distortion — ITO = 45 dBm Typ @ $f = 300$ MHz

LT3046

$I_C = 150$ mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



TO-46
CASE 26-03, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.15	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5$ mA, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	50	—	μ Adc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mA, $I_C/I_B = 10$)	$V_{CE(sat)}$	—	300	—	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 10$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	1.5	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum ($V_{CE} = 8\text{ V}$, $I_C = 25\text{ mA}$, $f = 300\text{ MHz}$)	NF_{MIN}	—	2.5	—	dB
Cutoff Frequency ($V_{CE} = 14\text{ V}$, $I_C = 40\text{ mA}$)	f_T	—	3	—	GHz
Maximum Unilateral Gain ($V_{CE} = 14\text{ V}$, $I_C = 40\text{ mA}$, $f = 300\text{ MHz}$)	G_{UMAX}	—	17.5	—	dB
Insertion Gain ($V_{CE} = 14\text{ V}$, $I_C = 40\text{ mA}$, $f = 300\text{ MHz}$)	$|S_{21}|^2$	—	15.5	—	dB
Output Power @ 1 dB Compression ($V_{CE} = 14\text{ V}$, $I_C = 40\text{ mA}$, $f = 300\text{ MHz}$)	$P_{O1\text{ dB}}$	—	22	—	dBm
Third Order Intercept ($V_{CE} = 14\text{ V}$, $I_C = 40\text{ mA}$, $f = 300\text{ MHz}$)	ITO	—	40	—	dBm

TYPICAL CHARACTERISTICS

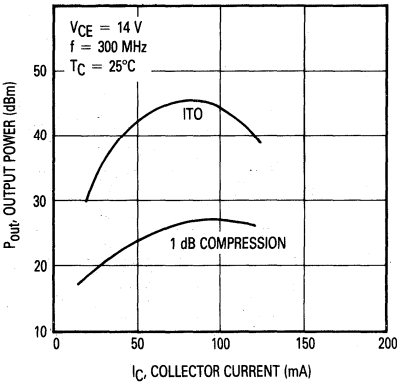


Figure 1. Third Order Intercept and 1 dB Compression versus Current

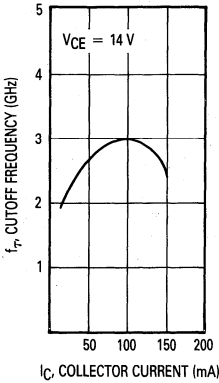


Figure 2. Gain-Bandwidth Product versus Collector Current

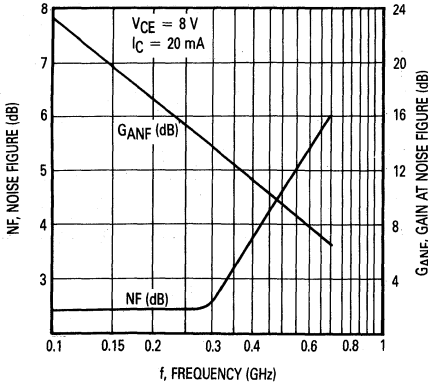


Figure 3. Noise Figure and Associated Gain versus Frequency

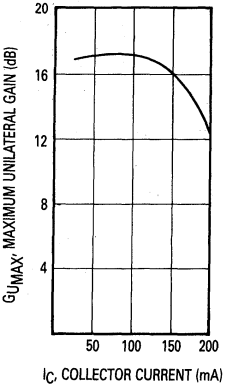


Figure 4. G_{UMAX} versus Collector Current

TYPICAL CHARACTERISTICS

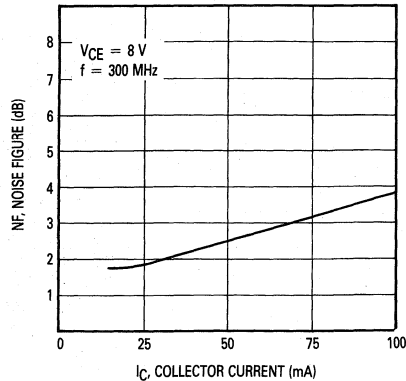


Figure 5. Noise Figure versus Collector Current

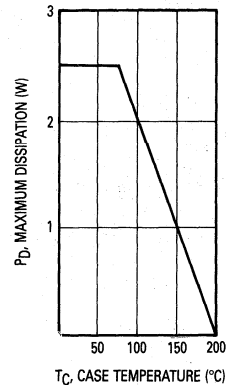


Figure 6. Dissipation versus Temperature

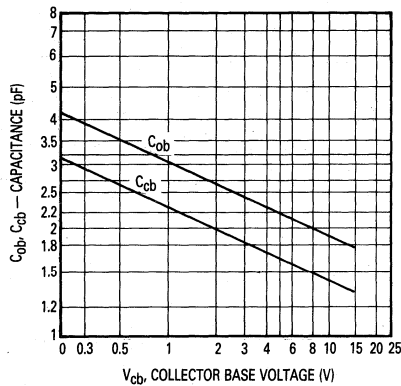


Figure 7. Junction Capacitance versus Voltage

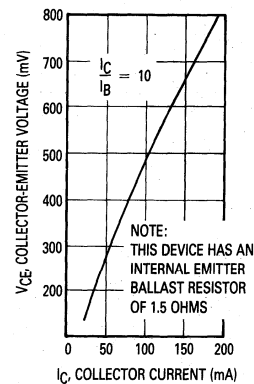


Figure 8. Collector Saturation Characteristics

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂		k
VCE = 8 V, IC = 20 mA									
100	-6.58	-117.7	21.66	108.6	-25.92	57.2	-4.36	-60.6	0.437
200	-8.53	-155.2	15.98	90.3	-22.80	63.9	-8.88	-61.1	0.915
300	-8.45	-175.7	12.75	80.0	-20.03	70.0	-10.29	-70.6	1.020
400	-8.45	-171.1	10.41	72.2	-17.73	73.8	-10.50	-76.1	1.050
500	-8.27	-155.2	8.56	65.0	-15.95	75.6	-10.69	-89.3	1.095
600	-7.81	-147.3	7.22	59.6	-14.20	77.2	-11.13	-96.4	1.076
700	-7.96	-135.9	6.11	55.4	-12.73	78.1	-9.84	-105.7	1.069
800	-7.46	-127.7	5.24	48.6	-11.24	76.2	-10.27	-126.1	1.064
900	-7.18	-119.6	4.35	43.9	-10.00	75.2	-10.02	-136.2	1.057
1000	-7.49	-109.8	3.60	40.2	-8.94	73.9	-8.06	-146.6	1.058
VCE = 14 V, IC = 40 mA									
100	-4.36	-113.9	23.66	115.4	-28.54	47.9	-5.28	-46.6	0.410
200	-4.72	-145.8	18.57	97.2	-26.42	48.2	-8.32	-54.8	0.684
300	-4.58	-159.9	15.39	59.0	-24.90	53.2	-9.31	-64.7	0.842
400	-4.66	-168.3	12.97	80.8	-23.69	58.4	-9.66	-65.9	0.967
500	-4.58	-174.3	11.04	74.9	-22.47	63.9	-9.65	-72.2	1.041
600	-3.77	-179.2	9.47	70.3	-21.39	68.8	-9.31	-77.0	0.956
700	-4.57	-177.1	8.32	64.7	-20.12	71.6	-8.64	-81.9	1.057
800	-4.55	-172.5	7.16	60.7	-19.06	75.4	-8.25	-86.9	1.067
900	-4.47	-168.7	6.21	56.9	-17.99	78.0	-7.69	-91.2	1.030
1000	-4.29	-164.4	5.27	53.6	-17.01	80.5	-7.38	-96.4	1.015

Figure 9. Common Emitter S-Parameters

The RF Line **NPN Silicon** **High Frequency Transistors**

... designed for use in high frequency, high current applications requiring low distortion.

- High Gain — $|S_{21}|^2 = 15 \text{ dB Typ @ } f = 500 \text{ MHz}$
- High Cutoff Frequency — $f_{T \text{ die}} = 6 \text{ GHz Typ}$
- Diffused Ballast Resistors
- Gold Metallization
- Ion Implantation
- Available in Chip Only — Order CD6150

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5 \text{ mA}, I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1 \text{ mA}, I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}, I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10 \text{ V}, I_E = 0$)	I_{CBO}	—	—	100	μAdc
Collector Cutoff Current ($V_{CE} = 9 \text{ V}, I_B = 0$)	I_{CEO}	—	—	500	μAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50 \text{ mA}, V_{CE} = 5 \text{ V}$)	h_{FE}	70	150	300	—
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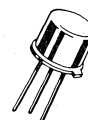
DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 10 \text{ V}, I_E = 0, f = 1 \text{ MHz}$)	C_{cb}	—	—	2.5 2	pF
Emitter Resistance ($I_E = 100 \text{ mA}$)	R_E	—	1.4	—	Ω

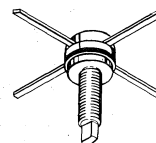
(continued)

LT4217
LT4239
CD6150

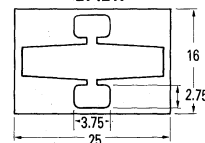
$I_C = 400 \text{ mA}$
HIGH FREQUENCY
TRANSISTORS
NPN SILICON



TO-39
CASE 79-04, STYLE 1
LT4239



TO-117A
CASE 244D-01, STYLE 1
LT4217



(DIMENSIONS IN MILS)
CHIP OUTLINE
CD6150

LT4217, LT4239, CD6150

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Optimum ($V_{CE} = 8\text{ V}$, $I_C = 50\text{ mA}$, $f = 500\text{ MHz}$)	$NF_{OPT.}$	—	2.5	—	dB
Cutoff Frequency ($V_{CE} = 8\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	f_T	—	5.5	—	GHz
		—	5	—	
		—	6	—	
Insertion Gain ($V_{CE} = 8\text{ V}$, $I_C = 90\text{ mA}$, $f = 500\text{ MHz}$)	$|S_{21}|^2$	—	15	—	dB
		—	14	—	
		—	18	—	

2

TYPICAL CHARACTERISTICS

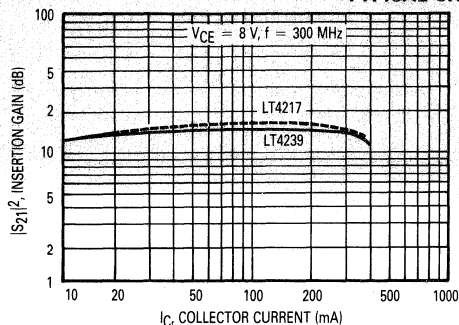


Figure 1. Common Emitter Insertion Gain (50 Ω) versus Collector Current

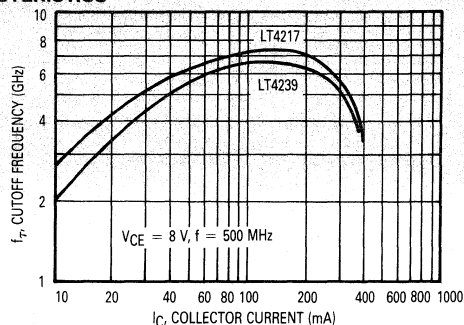


Figure 2. Gain Bandwidth Product versus Collector Current

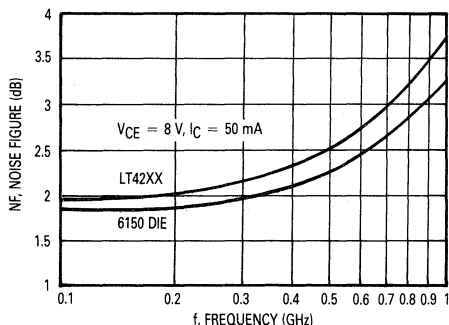


Figure 3. Noise Figure versus Frequency

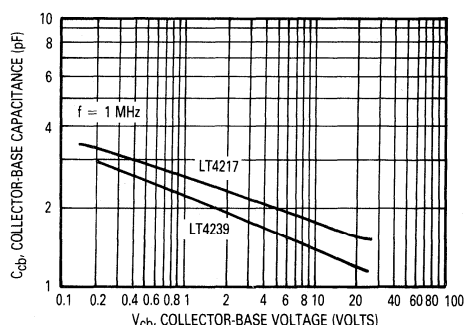


Figure 4. Collector-Base Capacitance versus Voltage

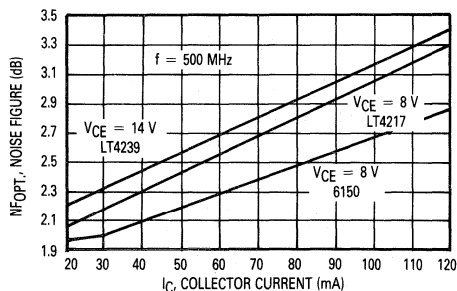


Figure 5. Noise Figure versus Collector Current

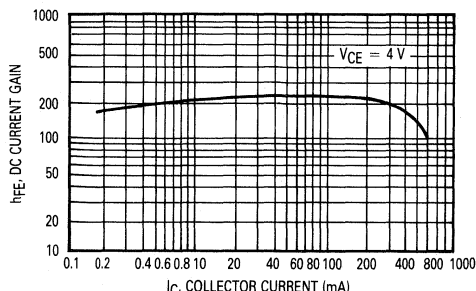


Figure 6. DC Beta versus Collector Current

Frequency (GHz)	S ₁₁		S ₁₂		S ₂₁		S ₂₂	
	dB	Ang	dB	Ang	dB	Ang	dB	Ang
V_{CE} = 8 V, I_C = 50 mA								
200	-7.78	-161.1	-23.35	62.3	19.21	92.1	-10.66	-116.6
300	-7.73	-177.8	-20.64	64.7	15.86	83.2	-11.37	-129.6
400	-7.59	171.4	-18.55	66.1	13.62	76.2	-11.49	-137.2
500	-7.41	163.1	-16.87	66.9	11.73	71.5	-11.09	-142.9
600	-7.28	155.8	-15.33	66.0	10.29	66.2	-10.78	-145.7
700	7.22	149.5	-14.17	64.3	9.06	60.1	-10.35	-150.6
800	-7.12	143.5	-13.03	63.8	7.97	56.0	-9.90	-152.7
900	-7.10	138.2	-12.23	61.9	7.08	52.0	-9.50	-156.4
1000	-7.08	132.8	-11.39	60.5	6.27	47.4	-8.97	-159.2
1100	-7.10	126.4	-11.07	58.8	5.59	44.1	-8.35	-161.3
1200	-7.10	120.0	-10.24	58.5	5.12	39.1	-8.06	-165.3
1300	-7.10	114.6	-9.72	56.6	4.33	36.7	-7.84	-168.9
1400	-7.16	108.2	-9.14	55.0	4.00	33.2	-7.61	-172.2
1500	-7.19	102.1	-8.41	53.5	3.51	28.7	-7.35	-175.7
1600	-7.18	95.7	-7.88	51.6	3.05	28.1	-7.02	-179.3
1700	-7.14	88.8	-7.43	49.3	2.89	22.6	-6.88	177.4
1800	-6.94	82.2	-6.94	46.9	2.37	20.2	-6.67	173.3
1900	-6.67	76.5	-6.39	45.5	2.42	19.1	-6.64	169.6
2000	-6.51	71.5	-5.87	42.0	2.01	13.0	-6.52	164.7
V_{CE} = 14 V, I_C = 90 mA								
200	-9.03	-162.7	-23.74	61.7	19.99	94.8	-13.45	-120.5
300	-8.84	-179.4	-20.90	64.6	16.70	85.4	-13.54	-132.0
400	-8.62	169.9	-18.70	66.1	14.46	78.4	-13.34	-138.4
500	-8.43	161.7	-17.03	66.8	12.57	73.9	-12.67	-142.9
600	-8.28	154.5	-15.49	65.7	11.14	68.4	-12.25	-145.0
700	-8.18	148.2	-14.32	63.9	9.91	62.5	-11.70	-149.2
800	-8.06	142.5	-13.19	63.2	8.83	58.3	-11.15	-150.8
900	-8.07	137.3	-12.40	61.4	7.90	54.4	-10.67	-154.2
1000	-8.04	131.8	-11.59	59.8	7.09	49.9	-10.07	-156.6
1100	-8.04	125.8	-11.27	58.2	6.42	46.8	-9.35	-158.9
1200	-8.05	119.4	-10.53	58.0	5.90	42.3	-9.01	-163.0
1300	-8.07	114.1	-9.93	55.8	5.22	39.2	-8.87	-165.7
1400	-8.15	107.6	-9.41	54.4	4.83	35.9	-8.60	-168.8
1500	-8.17	101.4	-8.72	52.8	4.34	31.4	-8.30	-172.1
1600	-8.18	94.9	-8.20	51.0	3.85	30.5	-7.95	-175.4
1700	-8.10	88.1	-7.78	48.9	3.70	25.3	-7.78	-178.4
1800	-7.88	81.4	-7.31	46.8	3.17	22.6	-7.54	172.0
1900	-7.57	76.0	-6.77	45.4	3.17	21.5	-7.50	174.7
2000	-7.38	71.0	-6.28	42.3	2.82	15.3	-7.40	170.2

Figure 7. LT4217 Common Emitter S-Parameters

Frequency (GHz)	S ₁₁		S ₁₂		S ₂₁		S ₂₂	
	dB	Ang	dB	Ang	dB	Ang	dB	Ang
V_{CE} = 8 V, I_C = 50 mA								
200	-11.60	-144.8	-20.45	68.0	17.41	89.4	-12.42	-105.7
300	-13.07	-166.2	-17.54	69.0	14.16	82.1	-12.68	-118.1
400	-13.54	173.2	-15.40	68.3	11.93	74.2	-12.21	-121.9
500	-12.87	157.7	-13.64	68.0	10.18	70.4	-11.80	-122.6
600	-12.28	150.0	-12.27	66.3	8.73	63.4	-11.70	-123.6
700	-12.24	145.2	-11.01	64.9	7.71	59.1	-11.61	-126.7
800	-12.92	140.1	-10.15	63.3	6.77	54.1	-11.43	-131.4
900	-13.83	128.6	-9.18	61.1	6.13	50.0	-10.83	-136.3
1000	-13.78	112.9	-8.51	59.3	5.41	46.4	-10.08	-139.8
1100	-12.91	104.2	-8.09	55.0	4.81	40.5	-8.44	-140.2
1200	-12.03	99.8	-7.48	53.3	4.27	36.8	-7.96	-141.2
1300	-11.82	99.7	-7.00	51.1	3.66	33.1	-7.79	-142.0
1400	-12.19	98.6	-6.49	49.6	3.35	29.6	-7.63	-143.8
1500	-13.10	94.6	-6.09	47.7	3.03	26.3	-7.43	-147.1
1600	-14.04	83.3	-5.74	46.5	2.78	22.7	-7.18	-149.8
1700	-13.92	72.7	-5.32	44.0	2.61	20.3	-6.84	-152.4
1800	-13.47	65.5	-4.98	43.1	2.26	18.2	-6.64	-154.0
1900	-13.26	62.5	-4.62	40.3	2.08	15.5	-6.26	-154.9
2000	-13.61	60.7	-4.19	39.9	1.87	13.1	-6.28	-156.3
V_{CE} = 14 V, I_C = 90 mA								
200	-12.86	-141.3	-20.72	67.8	17.84	90.1	-13.31	-99.5
300	-14.72	-163.9	-17.71	69.2	14.62	82.8	-13.54	-112.0
400	-15.30	172.9	-15.59	68.3	12.36	75.0	-12.90	-115.6
500	-14.45	155.4	-13.80	67.9	10.61	71.2	-12.33	-116.2
600	-13.70	147.5	-12.49	66.2	9.15	64.3	-12.15	-116.9
700	-13.68	143.2	-11.20	64.6	8.13	60.0	-12.01	-119.9
800	-14.47	137.7	-10.39	63.0	7.15	55.1	-11.85	-124.6
900	-15.58	125.0	-9.42	60.7	6.51	50.8	-11.20	-129.7
1000	-15.33	106.9	-8.77	59.1	5.76	47.3	-10.39	-133.6
1100	-14.18	96.9	-8.34	54.9	5.18	41.6	-8.68	-135.1
1200	-13.13	93.5	-7.70	53.0	4.62	37.8	-8.15	-136.1
1300	-12.96	94.2	-7.32	51.3	4.00	34.0	-7.91	-136.9
1400	-13.40	93.1	-6.81	49.8	3.68	30.5	-7.72	-138.6
1500	-14.46	89.3	-6.42	48.0	3.36	27.2	-7.48	-141.9
1600	-15.39	76.4	-6.09	47.0	3.07	23.4	-7.21	-144.6
1700	-15.08	65.2	-5.67	44.6	2.88	21.1	-6.83	-147.3
1800	-14.47	58.5	-5.35	43.9	2.47	18.8	-6.48	-148.9
1900	-14.21	56.0	-4.99	41.3	2.27	16.0	-6.15	-149.7
2000	-14.54	54.5	-4.58	41.2	2.05	13.5	-6.12	-151.0

Figure 8. LT4239 Common Emitter S-Parameters

Frequency (GHz)	S ₁₁		S ₁₂		S ₂₁		S ₂₂	
	dB	Ang	dB	Ang	dB	Ang	dB	Ang

V_{CE} = 14 V, I_C = 30 mA

100	-2.30	-114.0	-28.21	36.0	27.35	118.7	-4.84	-76.7
200	-2.40	-143.8	-27.16	27.7	22.62	102.0	-7.85	-105.7
300	-2.41	-156.1	-26.64	26.3	19.48	93.6	-9.18	-119.9
400	-2.42	-163.1	-26.57	27.9	17.18	87.3	-9.69	-127.7
500	-2.25	-166.2	-26.13	28.8	15.17	82.9	-9.97	-130.4
550	-2.23	-167.6	-26.00	30.3	14.44	81.3	-9.97	-131.7
600	-2.21	-169.0	-25.81	30.5	13.70	79.6	-9.97	-132.5
650	-2.18	-170.2	-25.67	32.8	13.02	77.5	-9.95	-133.3
700	-2.17	-171.3	-25.62	33.5	12.44	75.6	-9.90	-134.4
750	-2.14	-172.2	-25.35	34.7	11.81	74.1	-9.70	-135.4
800	-2.15	-173.2	-25.27	36.3	11.30	72.4	-9.58	-135.3
850	-2.14	-174.0	-25.10	37.7	10.74	70.8	-9.47	-135.6
900	-2.11	-174.8	-24.96	36.7	10.27	69.1	-9.26	-135.3
950	-2.08	-175.6	-24.08	40.0	9.75	67.9	-9.17	-135.0
1000	-2.11	-177.3	-24.70	42.1	9.16	63.2	-9.10	-135.0
1100	-2.10	-178.7	-24.35	44.3	8.46	61.9	-8.81	-130.6
1200	-2.10	180.0	-24.03	46.9	7.54	59.1	-8.46	-136.5
1300	-2.13	178.9	-23.70	48.8	6.81	56.2	-7.99	-136.3
1400	-2.15	178.1	-23.28	51.6	6.10	53.6	-7.82	-135.4
1500	-2.16	177.0	-23.19	53.9	5.35	51.4	-7.40	-136.1
1600	-2.19	176.2	-22.78	54.9	4.50	47.9	-7.06	-136.3
1700	-2.18	175.6	-22.39	55.7	4.05	44.6	-6.63	-135.8
1800	-2.18	174.9	-21.97	57.5	3.42	42.1	-6.40	-138.6
1900	-2.19	174.4	-21.62	59.6	2.93	40.7	-6.05	-136.8
2000	-2.17	173.0	-21.34	69.9	2.34	39.2	-5.75	-136.8

V_{CE} = 14 V, I_C = 100 mA

100	-2.65	-125.7	-30.13	36.1	28.61	115.1	-5.35	-95.4
200	-2.48	-151.5	-28.82	29.2	23.82	100.4	-7.35	-125.7
300	-2.42	-161.6	-28.27	29.6	20.42	93.0	-8.07	-139.9
400	-2.40	-167.3	-27.69	33.5	18.10	87.4	-8.28	-146.9
500	-2.21	-169.8	-27.21	35.8	16.13	83.1	-8.41	-150.0
550	-2.19	-171.0	-26.00	37.6	15.46	81.0	-8.48	-152.5
600	-2.18	-172.1	-26.58	38.8	14.72	81.0	-8.48	-152.5
650	-2.16	-173.1	-26.32	40.7	14.06	79.1	-8.58	-153.0
700	-2.14	-174.1	-26.14	41.8	13.47	77.6	-8.56	-154.7
750	-2.12	-175.0	-25.76	43.1	12.85	76.3	-8.40	-155.2
800	-2.12	-175.7	-25.59	45.0	12.33	74.8	-8.43	-155.0
850	-2.11	-176.4	-25.26	46.0	11.78	73.4	-8.38	-155.2
900	-2.11	-177.1	-25.17	46.2	11.31	72.0	-8.29	-154.7
950	-2.07	-177.8	-24.87	47.6	10.78	70.1	-8.29	-154.6
1000	-2.10	-179.4	-24.74	49.8	10.20	66.6	-8.28	-153.6
1100	-2.09	179.4	-24.21	51.4	9.49	65.5	-8.15	-154.8
1200	-2.10	178.2	-23.81	53.4	8.59	63.1	-7.97	-154.3
1300	-2.12	177.2	-23.34	54.6	7.89	60.5	-7.69	-153.2
1400	-2.14	176.5	-22.87	56.8	7.20	58.6	-7.72	-152.0
1500	-2.16	175.5	-22.59	58.6	6.46	56.6	-7.46	-151.8
1600	-2.18	174.7	-22.28	59.2	5.73	53.6	-7.24	-151.1
1700	-2.18	174.2	-21.84	59.4	5.21	56.2	-6.95	-149.8
1800	-2.19	173.6	-21.38	60.4	4.62	48.2	-6.78	-149.7
1900	-2.20	173.1	-21.02	62.0	4.17	47.0	-6.52	-149.3
2000	-2.19	172.7	-20.74	62.8	3.61	45.6	-6.32	-148.2

Figure 9. CD6150 Common Emitter S-Parameters

The RF Line

NPN Silicon

High Frequency Transistor

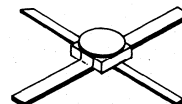
... designed primarily for use in low noise, small-signal amplifiers in satellite down conversion links, microwave radio relays, communication links, ECM receivers, oscillators, mixers and multipliers.

Use of ion implantation techniques, arsenic emitters, gold metallization and a hermetic package results in an ultra-reliable transistor with low noise, high gain and wide dynamic range.

- Fully Implanted Base and Emitter Structure
- Low Noise — 1.6 dB Typ @ $f = 1$ GHz
3 dB Typ @ $f = 2$ GHz
- High Cutoff Frequency — 6 GHz Typ
- Gold Metallization
- Hermetic Package

LT4700

$I_C = 50$ mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



100 MIL
CASE 303-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	50	mA _{dc}
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1$ mA, $I_B = 0$)	$V_{(BR)CEO}$	12	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	—	1	μA _{dc}

ON CHARACTERISTICS

DC Current Gain ($I_C = 25$ mA, $V_{CE} = 5$ V)	h_{FE}	70	150	300	—
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DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 8$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	—	0.6	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum ($V_{CE} = 8\text{ V}$, $I_C = 5\text{ mA}$) $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$ $f = 2\text{ GHz}$	NF _{MIN}	— — —	1.2 1.6 3	— 2.5 —	dB
Cutoff Frequency ($V_{CE} = 8\text{ V}$, $I_C = 25\text{ mA}$)	f_T	—	6	—	GHz
Maximum Unilateral Gain ($V_{CE} = 8\text{ V}$, $I_C = 25\text{ mA}$) $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$ $f = 2\text{ GHz}$	G _{UMAX}	— — —	26 21 16	— — —	dB
Insertion Gain ($V_{CE} = 8\text{ V}$, $I_C = 25\text{ mA}$) $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$ $f = 2\text{ GHz}$	|S ₂₁|²	— 13 —	21 15 10	— — —	dB
Maximum Oscillation Frequency ($V_{CE} = 8\text{ V}$, $I_C = 25\text{ mA}$)	f _{MAX}	—	7	—	GHz
Gain at Associated Noise Figure ($V_{CE} = 8\text{ V}$, $I_C = 5\text{ mA}$) $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$ $f = 2\text{ GHz}$	G _{ANF}	— — —	18 14 11	— — —	dB

TYPICAL CHARACTERISTICS

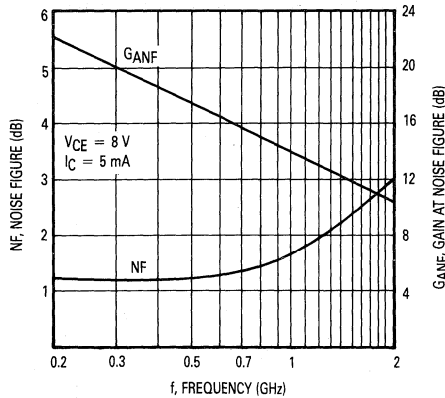


Figure 1. Noise Figure and Associated Gain versus Frequency

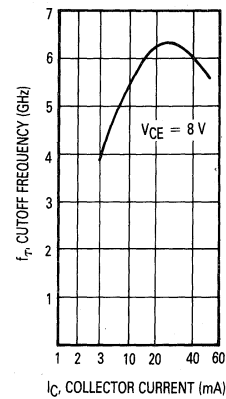


Figure 2. Gain-Bandwidth Product versus Collector Current

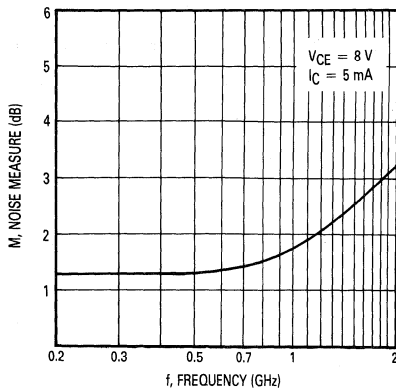


Figure 3. Noise Measure versus Frequency

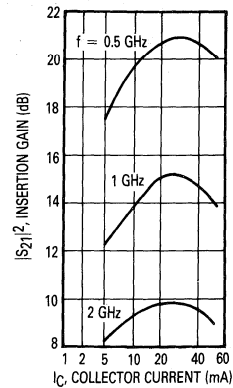


Figure 4. Insertion Gain versus Collector Current ($V_{CE} = 8\text{ V}$)

TYPICAL CHARACTERISTICS

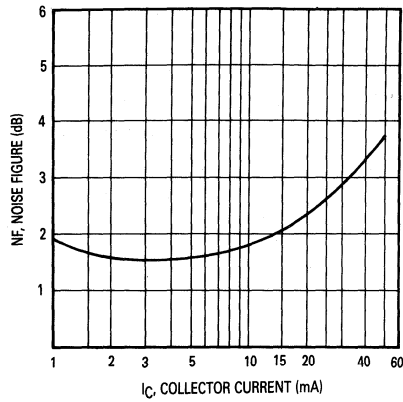


Figure 5. Noise Figure versus Collector Current

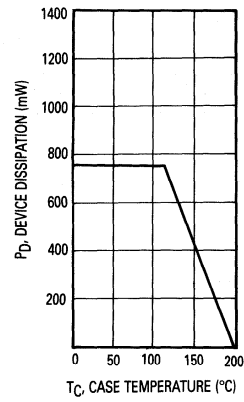


Figure 6. Device Dissipation Operating Range

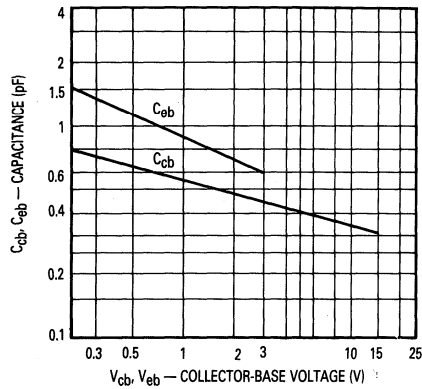


Figure 7. Junction Capacitance versus Voltage

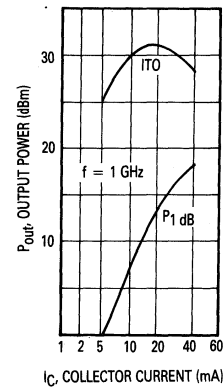


Figure 8. Third Order Intercept versus Collector Current ($V_{CE} = 8$ V)

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂		k
VCE = 8 V, IC = 5 mA									
100	-2.09	- 35.4	24.61	149.8	-33.54	71.3	-0.28	- 18.5	0.14632
150	-2.70	- 48.2	23.37	153.7	-32.03	66.7	-0.42	- 14.5	0.08388
200	-3.17	- 61.0	21.27	143.5	-30.61	56.5	-2.11	- 17.4	0.38362
250	-3.62	- 73.5	19.86	133.3	-29.07	51.8	-2.20	-28.6	0.34603
400	-3.66	-106.1	18.67	113.0	-26.98	40.3	-3.23	-29.9	0.43098
500	-3.91	-119.4	17.34	107.3	-26.32	37.3	-3.69	-30.4	0.48277
600	-4.00	-130.2	16.13	100.2	-25.82	34.5	-4.15	-32.8	0.54641
700	-4.07	-139.1	15.05	94.4	-25.56	32.7	-4.56	-33.2	0.62994
800	-4.11	-146.6	14.04	89.9	-25.20	31.1	-4.75	-35.7	0.67527
900	-4.14	-152.9	13.06	85.1	-25.04	30.8	-5.10	-37.1	0.76699
1000	-4.76	-161.3	12.15	79.1	-25.02	34.9	-5.10	-36.8	0.91025
1100	-4.79	-166.5	11.41	75.5	-24.88	35.2	-5.33	-37.9	0.99839
1200	-4.81	-171.3	10.70	71.9	-24.55	35.8	-5.34	-39.0	1.03922
1300	-4.81	-175.7	10.03	68.3	-24.34	36.4	-5.42	-41.8	1.09306
1400	-4.80	-179.6	9.41	65.1	-24.19	37.7	-5.55	-43.1	1.16138
1500	-4.77	-176.8	8.82	61.6	-23.92	36.9	-5.50	-45.4	1.19230
1600	-4.77	-173.2	8.24	58.6	-23.73	38.9	-5.53	-47.3	1.24361
1700	-4.82	-171.1	7.70	57.1	-23.50	40.0	-5.54	-49.1	1.29489
1800	-4.72	-167.4	7.25	52.6	-23.31	40.4	-5.54	-51.3	1.31465
1900	-4.70	-164.6	6.92	50.1	-22.96	41.3	-5.57	-54.0	1.30445
2000	-4.68	-161.8	6.48	47.3	-22.74	42.8	-5.55	-56.0	1.32750

V_{CE} = 8 V, I_C = 25 mA									
100	-5.83	-88.2	30.87	131.0	-37.23	55.3	-2.18	-27.5	0.33256
150	-5.77	-107.6	29.28	125.3	-35.66	56.8	-3.33	-28.6	0.38799
200	-5.54	-121.6	27.32	119.5	-34.93	52.9	-4.67	-30.6	0.52604
250	-5.43	-132.5	25.47	112.9	-34.55	53.8	-5.39	-32.4	0.64475
400	-4.86	-152.7	22.60	96.7	-32.75	45.9	-7.29	-34.6	0.82367
500	-4.77	-160.5	20.82	92.8	-31.90	47.6	-7.79	-33.2	0.92234
600	-4.72	-166.2	19.35	87.7	-31.00	49.6	-8.18	-33.6	0.99615
700	-4.66	-170.7	18.07	83.4	-30.21	50.8	-8.47	-32.9	1.06180
800	-4.63	-174.6	16.93	80.0	-29.45	51.7	-8.64	-34.9	1.10767
900	-4.58	-177.9	15.94	76.7	-29.79	52.7	-8.84	-35.3	1.15458
1000	-5.29	-176.5	14.85	72.4	-27.18	59.5	-8.36	-34.0	1.16067
1100	-5.27	-173.3	14.02	69.5	-26.60	59.4	-8.50	-35.3	1.19985
1200	-5.22	-170.4	13.20	66.3	-25.95	59.5	-8.48	-36.3	1.21402
1300	-5.17	-167.7	12.50	63.2	-25.28	59.8	-8.55	-39.2	1.21229
1400	-5.13	-165.3	11.84	61.0	-24.82	60.2	-8.61	-40.4	1.24004
1500	-5.08	-163.0	11.23	57.8	-24.24	58.8	-8.54	-42.8	1.23090
1600	-5.05	-160.8	10.65	55.2	-23.81	59.7	-8.52	-44.9	1.24442
1700	-5.10	-159.4	10.07	54.4	-23.86	59.6	-8.53	-46.5	1.27095
1800	-4.97	-156.4	9.62	50.1	-22.93	58.9	-8.52	-49.1	1.25286
1900	-4.97	-154.5	9.22	48.1	-22.44	58.9	-8.57	-51.2	1.24397
2000	-4.96	-152.6	8.78	45.0	-22.10	59.2	-8.47	-54.0	1.24979

Figure 9. Common Emitter S-Parameters

Freq.	NF _{OPT.}	Γ _S OPT.	R _n
0.5 GHz	1.2 dB	0.244 / 80°	0.72 Ω
1.0 GHz	1.6 dB	0.337 / -97°	0.63 Ω
1.5 GHz	2.3 dB	0.353 / -158°	0.31 Ω
2.0 GHz	3.0 dB	0.345 / -146°	1.15 Ω

Reflection coefficient of source and the noise resistance at optimum noise figure for V_{CE} = 8 V, I_C = 5 mA

Figure 10. Noise Parameters

The RF Line
NPN Silicon
High Frequency Transistor

... designed primarily for use in low noise, small-signal amplifiers in satellite down conversion links, microwave radio relays, communication links, ECM receivers, oscillators, mixers and multipliers.

Use of ion implantation techniques, arsenic emitters, gold metallization and a hermetic package results in an ultra-reliable transistor with low noise, high gain and wide dynamic range.

- Fully Implanted Base and Emitter Structure
- High Cutoff Frequency — 6 GHz Typ
- High Gain — 12.5 dB Typ @ $f = 500$ MHz
- Gold Metallization

LT4746

$I_C = 50$ mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



TO-46
 CASE 26-03, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	50	mA _{dc}
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1$ mA, $I_B = 0$)	$V_{(BR)CEO}$	12	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	—	1	μ A _{dc}

ON CHARACTERISTICS

DC Current Gain ($I_C = 25$ mA, $V_{CE} = 5$ V)	h_{FE}	70	150	300	—
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DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 8$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	1	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum ($V_{CE} = 8\text{ V}$, $I_C = 5\text{ mA}$) $f = 300\text{ MHz}$ $f = 500\text{ MHz}$ $f = 1000\text{ MHz}$	NFMIN	— — —	1.3 1.6 2.7	— — —	dB
Cutoff Frequency ($V_{CE} = 8\text{ V}$, $I_C = 25\text{ mA}$)	f_r	—	6	—	GHz
Maximum Unilateral Gain ($V_{CE} = 8\text{ V}$, $I_C = 25\text{ mA}$) $f = 300\text{ MHz}$ $f = 500\text{ MHz}$ $f = 1000\text{ MHz}$	G_{UMAX}	— — —	17 13 7.5	— — —	dB
Insertion Gain ($V_{CE} = 8\text{ V}$, $I_C = 25\text{ mA}$) $f = 300\text{ MHz}$ $f = 500\text{ MHz}$ $f = 1000\text{ MHz}$	$|S_{21}|^2$	— — —	16.5 12.5 7	— — —	dB
Gain at Associated Noise Figure ($V_{CE} = 8\text{ V}$, $I_C = 5\text{ mA}$) $f = 300\text{ MHz}$ $f = 500\text{ MHz}$ $f = 1000\text{ MHz}$	GANF	— — —	18 11.5 6.5	— — —	dB

TYPICAL CHARACTERISTICS

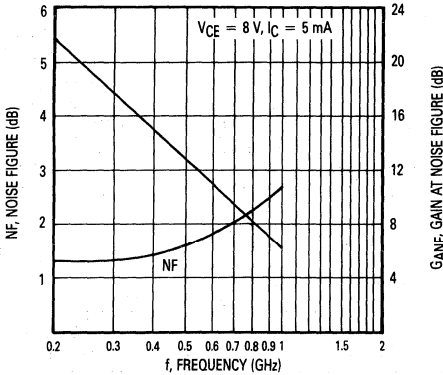


Figure 1. Noise Figure and Associated Gain versus Frequency

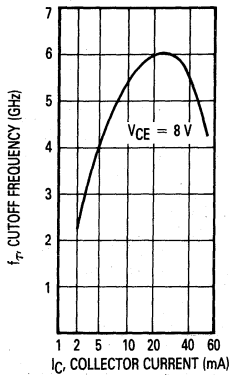


Figure 2. Gain-Bandwidth Product versus Collector Current

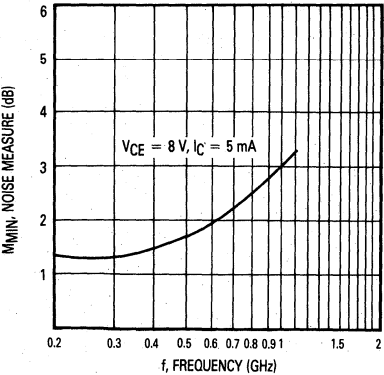


Figure 3. Noise Measure versus Frequency

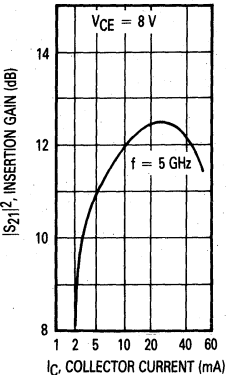


Figure 4. Insertion Gain versus Collector Current

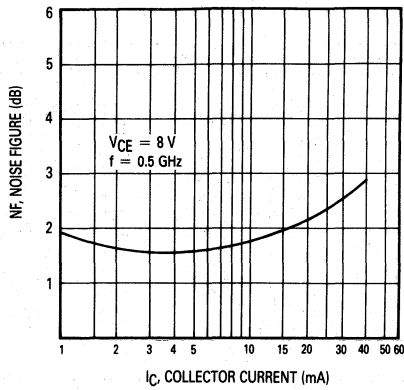


Figure 5. Noise Figure versus Collector Current

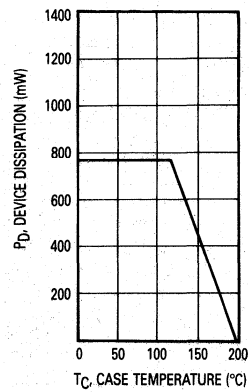


Figure 6. Device Dissipation Operating Range

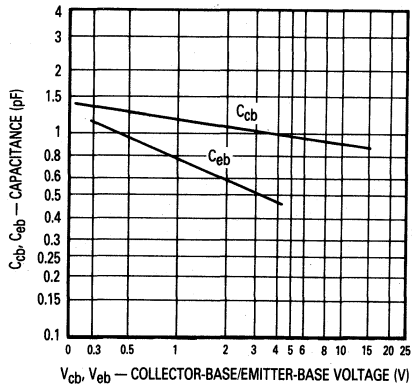


Figure 7. Junction Capacitance versus Voltage

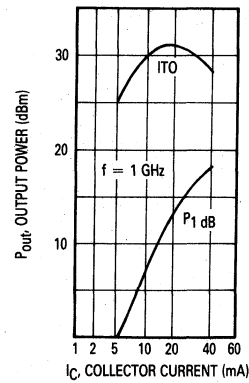


Figure 8. Typical Third Order Intercept versus Collector Current

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂		k
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V_{CE} = 8 V, I_C = 5 mA

100	- 2.59	- 40.1	20.17	139.2	-24.64	66.8	- 2.27	-33.3	0.358
200	- 6.05	- 64.3	17.28	118.1	-21.02	61.7	- 5.20	-47.8	0.627
300	- 8.99	- 80.1	14.68	106.5	-19.12	62.7	- 7.36	-53.2	0.813
400	-11.50	- 90.4	12.60	99.0	-17.68	65.4	- 8.84	-55.8	0.941
500	-13.74	- 99.7	10.95	94.0	-16.47	68.4	- 9.84	-56.6	1.025
600	-15.60	-108.9	9.53	89.4	-15.45	70.5	-10.61	-57.4	1.090
700	-17.56	-116.6	8.38	86.2	-14.47	72.8	-11.10	-58.7	1.128
800	-19.19	-126.7	7.50	83.5	-13.63	74.8	-11.41	-59.5	1.146
900	-20.86	-140.4	6.62	81.0	-12.88	76.7	-11.61	-60.1	1.169
1000	-22.84	-153.2	5.89	79.5	-12.22	79.0	-12.03	-61.4	1.190
1100	-22.60	-165.0	5.25	78.2	-11.70	81.1	-12.38	-62.2	1.207
1200	-22.39	170.8	4.59	77.6	-11.19	83.4	-12.48	-65.4	1.227

V_{CE} = 8 V, I_C = 25 mA

100	- 8.38	- 70.8	23.92	115.8	-27.49	68.7	- 6.46	-47.0	0.733
200	-13.65	- 96.8	19.76	101.8	-23.04	72.8	-10.39	-51.1	0.927
300	-16.74	-117.5	16.53	95.3	-20.17	75.9	-12.39	-50.3	0.997
400	-19.03	-135.2	14.22	91.0	-18.06	77.7	-13.58	-48.9	1.032
500	-20.61	-155.5	12.35	88.0	-16.37	79.3	-14.31	-47.5	1.055
600	-21.01	-173.0	10.92	85.0	-15.06	79.8	-14.72	-47.0	1.067
700	-21.62	168.6	9.77	82.9	-13.88	80.7	-15.04	-47.2	1.073
800	-21.18	154.5	8.78	81.2	-12.85	81.5	-15.13	-47.8	1.073
900	-20.13	142.6	7.85	79.4	-12.09	82.2	-15.11	-48.1	1.082
1000	-19.75	130.3	7.11	78.5	-11.32	83.6	-15.50	-48.6	1.086
1100	-18.95	129.5	6.44	77.7	-10.79	84.8	-15.94	-49.2	1.094
1200	-17.19	121.8	5.77	77.6	-10.25	86.3	-16.12	-52.6	1.101

Figure 9. Common Emitter S-Parameters

Freq.	NF _{OPT.}	Γ _S OPT.	R _n
0.3 GHz	1.3 dB	0.452 / +39°	0.81 Ω
0.5 GHz	1.6 dB	0.385 / +36°	0.32 Ω
0.7 GHz	2.0 dB	0.153 / +94°	0.38 Ω
1.0 GHz	2.7 dB	0.186 / +97°	0.88 Ω

Reflection coefficient of source and the noise resistance at optimum noise figure for V_{CE} = 8 V, I_C = 5 mA

Figure 10. Noise Parameters

The RF Line

NPN Silicon

High Frequency Transistor

... designed primarily for use in low noise, small-signal amplifiers in satellite down conversion links, microwave radio relays, communication links, ECM receivers, oscillators, mixers and multipliers.

Use of ion implementation techniques, arsenic emitters, gold metallization and a hermetic package results in an ultra-reliable transistor with low noise, high gain and wide dynamic range.

- Fully Implanted Base and Emitter Structure
- High Cutoff Frequency — 6 GHz Typ
- High Gain — 12.5 dB Typ @ $f = 500$ MHz
- Gold Metallization

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	50	mA
Operating Junction Temperature	T_J	200	°C
Storage Temperature	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1$ mA, $I_B = 0$)	$V_{(BR)CEO}$	12	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	—	1	μ Adc

ON CHARACTERISTICS

DC Current Gain ($I_C = 25$ mA, $V_{CE} = 5$ V)	h_{FE}	70	150	300	—
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DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 8$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	0.5	—	pF
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FUNCTIONAL TESTS

Noise Figure, Minimum ($V_{CE} = 8$ V, $I_C = 5$ mA)	$f = 300$ MHz	NF_{MIN}	—	1.3	—	dB
	$f = 500$ MHz		—	1.6	—	
	$f = 1000$ MHz		—	2.7	—	
Cutoff Frequency ($V_{CE} = 8$ V, $I_C = 25$ mA)		f_T	—	6	—	GHz
Maximum Unilateral Gain ($V_{CE} = 8$ V, $I_C = 25$ mA)	$f = 300$ MHz	G_{UMAX}	—	19	—	dB
	$f = 500$ MHz		—	14.5	—	
	$f = 1000$ MHz		—	8.5	—	
Insertion Gain ($V_{CE} = 8$ V, $I_C = 25$ mA)	$f = 300$ MHz	$|S_{21}|^2$	—	17	—	dB
	$f = 500$ MHz		—	13	—	
	$f = 1000$ MHz		—	7	—	
Gain at Associated Noise Figure ($V_{CE} = 8$ V, $I_C = 5$ mA)	$f = 300$ MHz	G_{ANF}	—	19	—	dB
	$f = 500$ MHz		—	13	—	
	$f = 1000$ MHz		—	7.5	—	

LT4772

$I_C = 50$ mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



TO-72
CASE 20-03, STYLE 10

TYPICAL CHARACTERISTICS

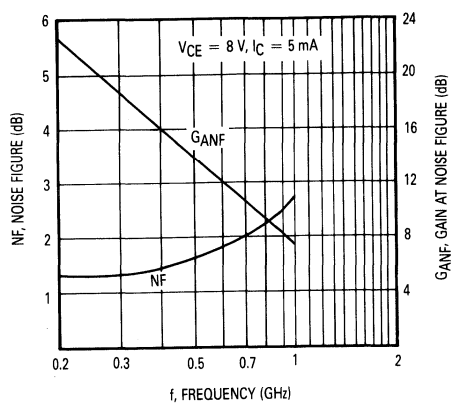


Figure 1. Noise Figure and Associated Gain versus Frequency

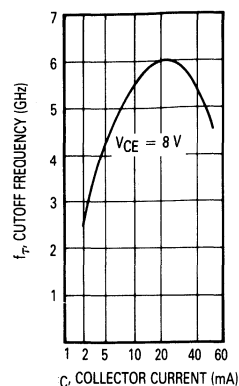


Figure 2. Gain-Bandwidth Product versus Collector Current

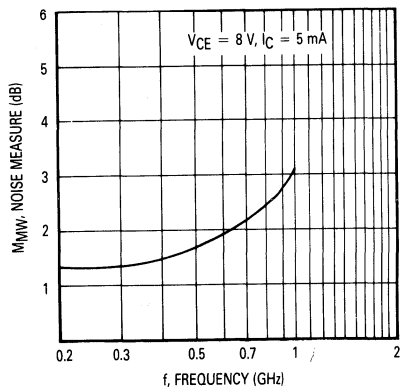


Figure 3. Noise Measure versus Frequency

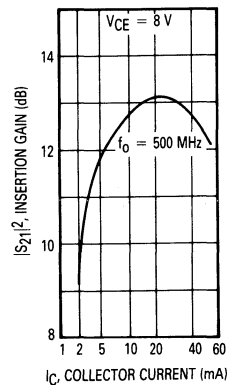


Figure 4. Insertion Gain versus Collector Current

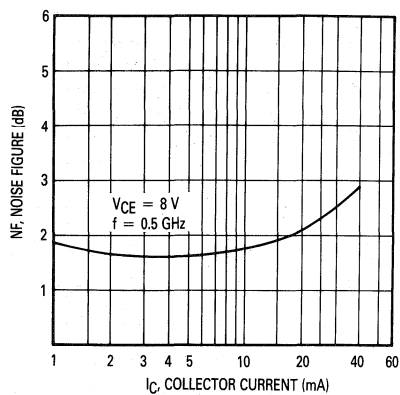


Figure 5. Noise Figure versus Collector Current

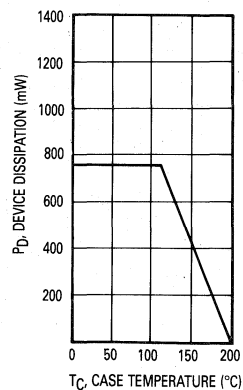


Figure 6. Device Dissipation Operating Range

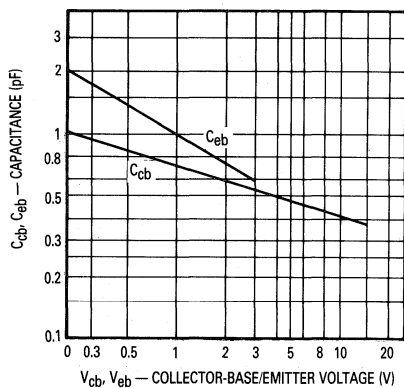


Figure 7. Junction Capacitance versus Voltage

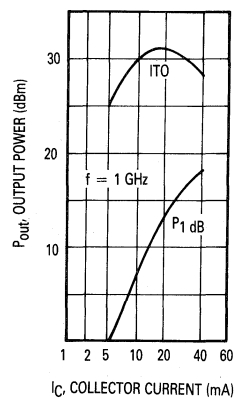


Figure 8. Typical Third Order Intercept versus Collector Current ($V_{CE} = 8\text{ V}$)

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂		k
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V_{CE} = 8 V, I_C = 25 mA

100	- 6.45	-35.8	24.14	116.4	-30.87	75.8	-3.93	-19.3	0.847
200	- 9.83	-36.1	20.29	101.4	-25.81	77.1	-5.42	-17.4	0.974
300	-11.46	-34.1	17.08	93.8	-22.72	77.7	-5.93	-15.8	1.025
400	-12.26	-30.9	14.70	88.3	-20.48	77.6	-6.08	-15.0	1.049
500	-12.82	-27.8	12.89	84.2	-18.83	77.5	-6.15	-14.8	1.066
600	-13.02	-26.9	11.38	79.9	-17.50	76.4	-6.10	-15.6	1.077
700	-12.88	-25.3	10.15	76.4	-16.50	75.6	-6.02	-16.8	1.089
800	-12.73	-25.7	9.06	73.2	-15.57	74.6	-5.89	-18.2	1.094
900	-12.60	-26.6	7.99	69.9	-15.00	73.9	-5.71	-20.3	1.117
1000	-12.07	-27.8	7.15	67.3	-14.52	73.2	-5.54	-22.1	1.134
1100	-11.76	-32.0	6.32	64.4	-14.11	72.4	-5.35	-23.7	1.151
1200	-11.37	-33.6	5.42	61.5	-14.02	71.6	-5.17	-27.9	1.199

V_{CE} = 8 V, I_C = 5 mA

100	- 2.29	-29.5	20.86	139.7	-29.35	73.0	-1.64	-18.0	0.468
200	- 5.22	-44.0	18.07	118.2	-24.93	69.4	-3.40	-23.1	0.742
300	- 7.65	-50.4	15.51	105.9	-22.49	69.8	-4.47	-23.2	0.905
400	- 9.52	-51.5	13.56	97.4	-20.62	70.8	-5.02	-22.7	0.995
500	-10.84	-50.4	11.81	91.4	-19.21	71.9	-5.35	-22.1	1.062
600	-11.82	-49.8	10.41	85.3	-18.07	71.9	-5.48	-22.3	1.104
700	-12.46	-46.7	9.19	81.3	-17.06	72.2	-5.53	-23.0	1.135
800	-12.81	-45.8	8.12	77.3	-16.31	72.3	-5.50	-24.2	1.162
900	-13.00	-44.5	7.21	73.4	-15.63	72.3	-5.38	-25.5	1.177
1000	-12.78	-43.2	6.33	70.3	-15.15	72.4	-5.28	-27.1	1.205
1100	-12.53	-45.4	5.54	67.0	-14.82	72.4	-5.15	-28.5	1.235
1200	-12.27	-45.4	4.66	63.9	-14.73	72.2	-4.99	-32.2	1.295

Figure 9. Common Emitter S-Parameters

Freq.	NFOPT.	Γ _S OPT.	R _n
0.3 GHz	1.3 dB	0.486 / +36°	0.78 Ω
0.5 GHz	1.6 dB	0.412 / +66°	0.130 Ω
0.7 GHz	2.0 dB	0.120 / +51°	0.720 Ω
1.0 GHz	2.7 dB	0.237 / +58°	0.8 Ω

Reflection coefficient of source and the noise resistance at optimum noise figure for V_{CE} = 8 V, I_C = 5 mA

Figure 10. Noise Parameters

The RF Line

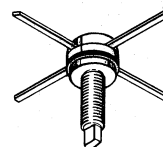
**PNP Silicon
High Frequency Transistor**

... specifically designed for CRT driver applications requiring high voltage and high frequency, such as high resolution color graphics video monitors.

- PNP Complement to LT1817
- High Voltage — $V_{(BR)CBO} = 80$ V Min
- High Cutoff Frequency — $f_T = 1500$ MHz Min
- Low Output Capacitance — $C_{cb} = 2.5$ pF Max @ $V_{CB} = 15$ V
- Gold Metallization
- Common Base Configuration

LT5817

$f_T = 1500$ MHz MIN
**HIGH FREQUENCY
TRANSISTOR
PNP SILICON**



**TO-177A
CASE 244D-01, STYLE 2**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	65	Vdc
Collector-Base Voltage	V_{CBO}	80	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	400	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1$ mA, $I_B = 0$)	$V_{(BR)CEO}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	80	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ V, $I_E = 0$)	I_{CBO}	—	—	20	μ Adc
Collector Cutoff Current ($V_{CE} = 50$ V, $V_{BE} = 0$)	I_{CES}	—	—	100	μ Adc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mA, $I_B = 5$ mA)	$V_{CE(sat)}$	—	—	800	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 15$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	—	2.5	pF
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FUNCTIONAL TESTS

Cutoff Frequency ($V_{CE} = 15$ V, $I_C = 50$ mA, $f = 200$ MHz)	f_T	1.5	—	—	GHz
Insertion Gain ($V_{CE} = 15$ V, $I_C = 50$ mA, $f = 200$ MHz)	$ S_{21} ^2$	15	—	—	dB

TYPICAL CHARACTERISTICS

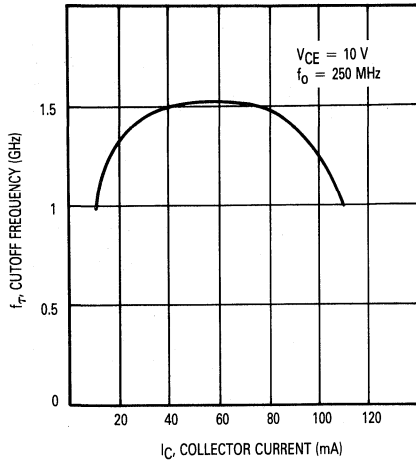


Figure 1. Gain Bandwidth Product versus Collector Current

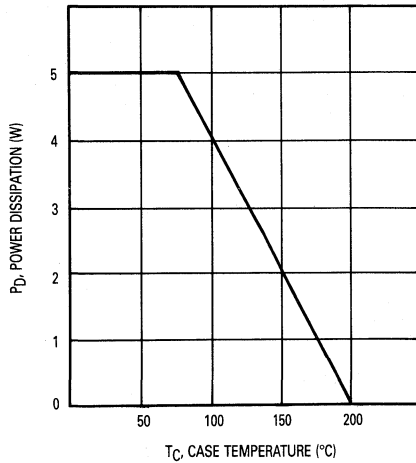


Figure 2. Power Dissipation versus Temperature

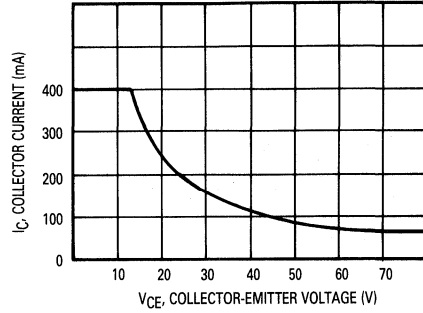


Figure 3. Safe Operating Area

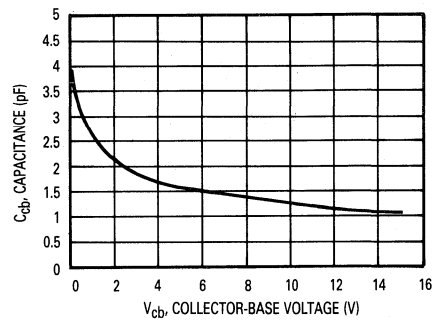


Figure 4. Junction Capacitance versus Voltage

The RF Line

PNP Silicon

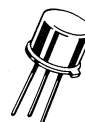
High Frequency Transistor

... specifically designed for CRT driver applications requiring high frequency and high voltage, such as high resolution color graphics video monitors.

- PNP Complement to LT1839
- High Voltage — $V_{(BR)CBO} = 80$ V Min
- High Cutoff Frequency — $f_T = 1500$ MHz Min
- Low Output Capacitance — $C_{cb} = 2.5$ pF Max @ $V_{CB} = 15$ V
- Gold Metallization

LT5839

$f_T = 1500$ MHz MIN
HIGH FREQUENCY
TRANSISTOR
PNP SILICON



TO-39
CASE 79-04, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	65	Vdc
Collector-Base Voltage	V_{CBO}	80	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	300	mA
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1$ mA, $I_B = 0$)	$V_{(BR)CEO}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	80	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ V, $I_E = 0$)	I_{CBO}	—	—	20	μA
Collector Cutoff Current ($V_{CE} = 50$ V, $V_{BE} = 0$)	I_{CES}	—	—	100	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mA, $I_B = 5$ mA)	$V_{CE(sat)}$	—	—	800	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 15$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	—	2.5	pF
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FUNCTIONAL TESTS

Cutoff Frequency ($V_{CE} = 10$ V, $I_C = 50$ mA, $f = 250$ MHz)	f_T	1.5	—	—	GHz
Insertion Gain ($V_{CE} = 10$ V, $I_C = 50$ mA, $f = 200$ MHz)	$ S_{21} ^2$	13	—	—	dB

TYPICAL CHARACTERISTICS

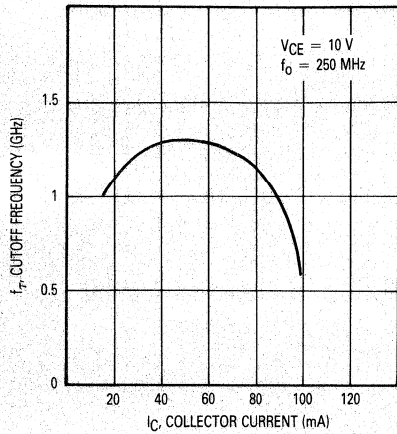


Figure 1. Gain Bandwidth Product versus Collector Current

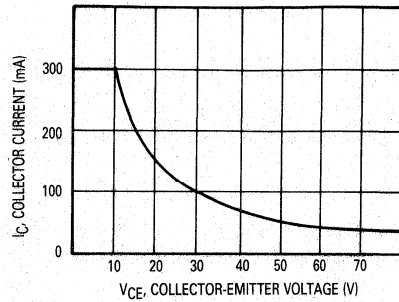


Figure 2. Safe Operating Area

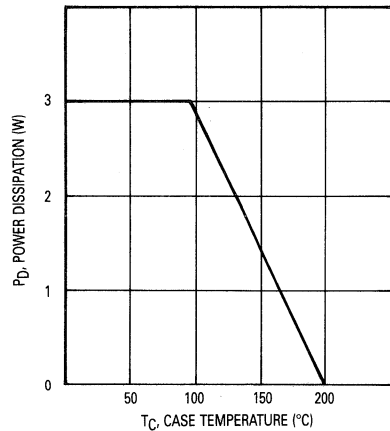


Figure 3. Power Dissipation versus Temperature

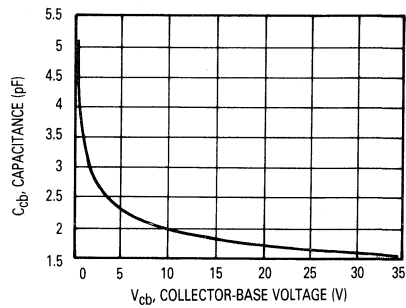


Figure 4. Junction Capacitance versus Voltage

MD4957

The RF Line

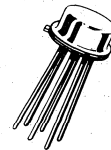
DUAL PNP SILICON ANNULAR 450 MHz AMPLIFIER

... designed for high-gain, low-noise amplifier, oscillator, and mixer applications.

- Low Noise Figure — NF = 3.0 dB (Typ) @ 450 MHz
6.0 dB (Typ) @ 1.0 GHz
- High Power Gain — G_{pe} = 18 dB (Typ) @ 450 MHz
13 dB (Typ) @ 1.0 GHz
- High Gain-Bandwidth Product — f_T = 1500 MHz (Typ)
- Low Collector-Base Capacitance — C_{cb} = 0.8 pF (Typ)

MULTIPLE DEVICES

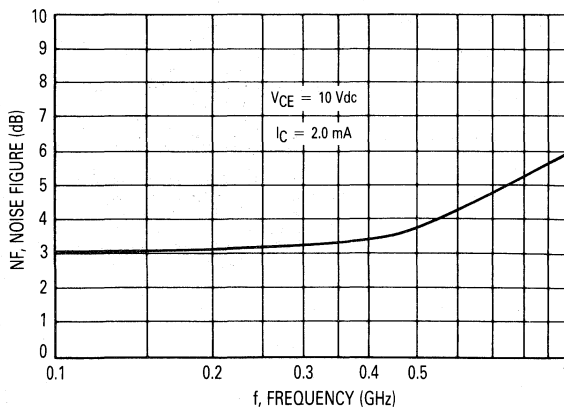
**DUAL PNP SILICON
AMPLIFIER**



MAXIMUM RATINGS (each side)

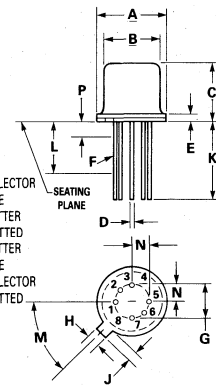
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Collector Current	I_C	30	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	One Side 200	mW
		Both Sides 400	
		1.15	2.3 mW/°C

FIGURE 1 — NOISE FIGURE (TYPICAL) versus FREQUENCY



STYLE 1:

- PIN 1. COLLECTOR
 2. BASE
 3. EMITTER
 4. OMITTED
 5. EMITTER
 6. BASE
 7. COLLECTOR
 8. OMITTED



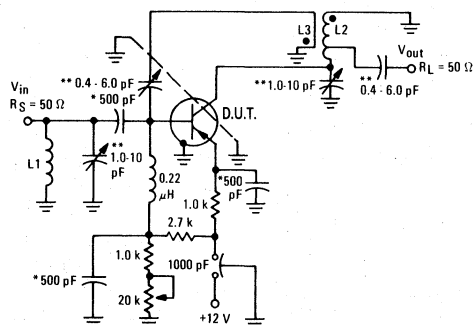
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.40	0.335	0.370
B	7.75	8.51	0.305	0.335
C	4.19	4.70	0.165	0.185
D	0.41	0.53	0.016	0.021
E	—	1.02	—	0.040
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.71	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	2.54 BSC		0.100 BSC	
P	—	1.27	—	0.050

CASE 654-02

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{A}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 20\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.1	μA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product ($I_C = 2.0\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 100\text{ MHz}$)	f_T	1000	1500	—	MHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 100\text{ kHz}$)	C_{cb}	—	0.8	1.5	pF
Small-Signal Current Gain ($I_C = 2.0\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{fe}	20	—	200	—
Collector-Base Time Constant ($I_E = 2.0\text{ mA}$, $V_{CB} = 10\text{ Vdc}$, $f = 63.6\text{ MHz}$)	$r_b'C_c$	—	10	20	ps
Noise Figure ($I_C = 2.0\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 450\text{ MHz}$) Figure 2 ($I_C = 2.0\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $R_S = 50\text{ Ohms}$, $f = 1.0\text{ GHz}$)	NF	—	3.0 6.0	—	dB
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 10\text{ Vdc}$, $I_C = 2.0\text{ mA}$, $f = 450\text{ MHz}$) ($V_{CE} = 10\text{ Vdc}$, $I_C = 2.0\text{ mA}$, $R_S = 50\text{ Ohms}$, $f = 1.0\text{ GHz}$)	G_{pe}	—	18 13	—	dB

FIGURE 2 — NOISE FIGURE AND POWER GAIN TEST CIRCUIT



*Button type capacitors

**Variable air piston type capacitors

1. L1 — silver plated brass bar, 1.0 in. lg by 0.25 in od.
2. L2 — silver plated brass bar, 1.5 in. lg by 0.25 in od. Tap is 0.25 in. from collector
3. L3 — 1/2 turn of AWG No. 16 wire 0.25 in. from and parallel to L2.
4. The noise source is a hot-cold body (All type 70 or equivalent) with a test receiver (All type 136 or equivalent).
5. Each half of dual transistor tested separately.

COMMON EMITTER Y PARAMETER VARIATIONS

Y PARAMETERS VS FREQUENCY

 $V_{CE} = 10 \text{ Vdc}$ $I_C = 2.0 \text{ mA}$

FIGURE 3 — INPUT ADMITTANCE

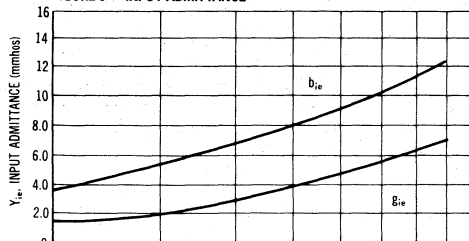


FIGURE 4 — FORWARD TRANSFER ADMITTANCE

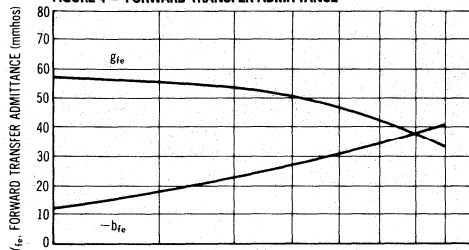


FIGURE 5 — OUTPUT ADMITTANCE

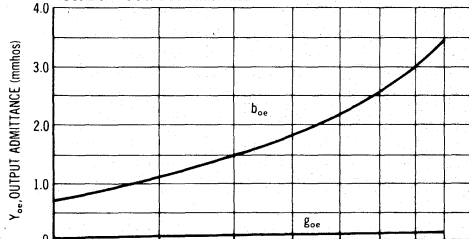
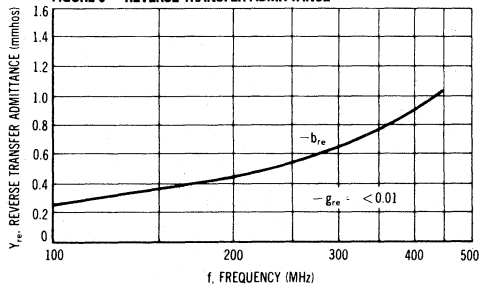


FIGURE 6 — REVERSE TRANSFER ADMITTANCE



Y PARAMETERS VS CURRENT

 $V_{CE} = 10 \text{ Vdc}$ $V_{CE} = 15 \text{ Vdc}$ $f = 450 \text{ MHz}$

FIGURE 7 — INPUT ADMITTANCE

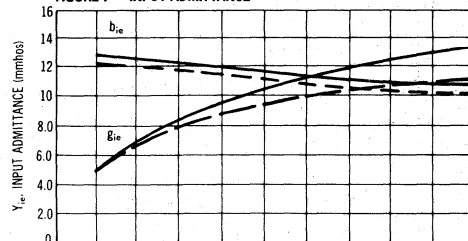


FIGURE 8 — FORWARD TRANSFER ADMITTANCE

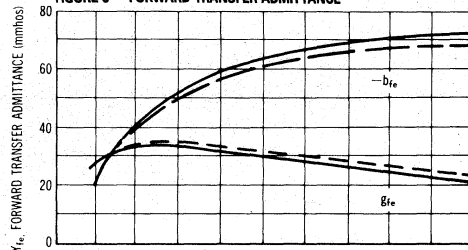


FIGURE 9 — OUTPUT ADMITTANCE

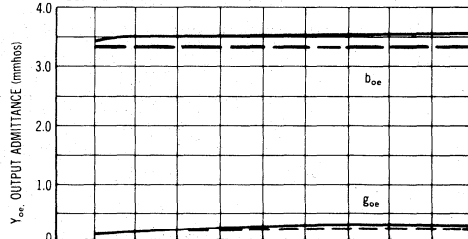
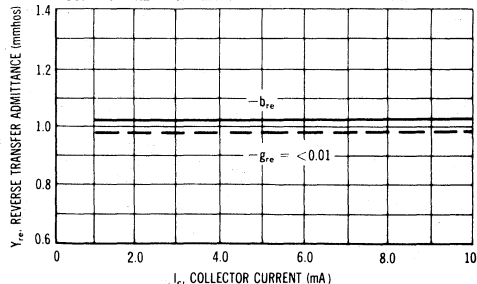
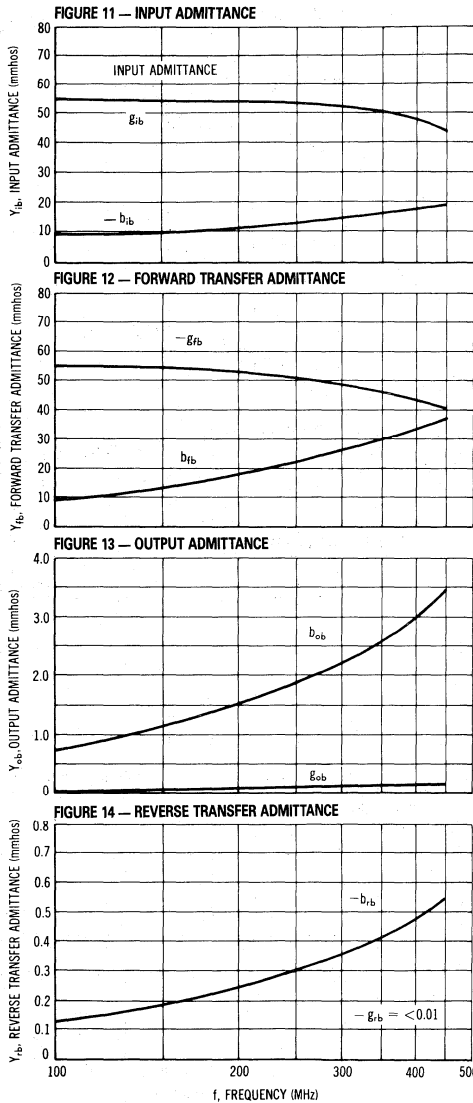


FIGURE 10 — REVERSE TRANSFER ADMITTANCE

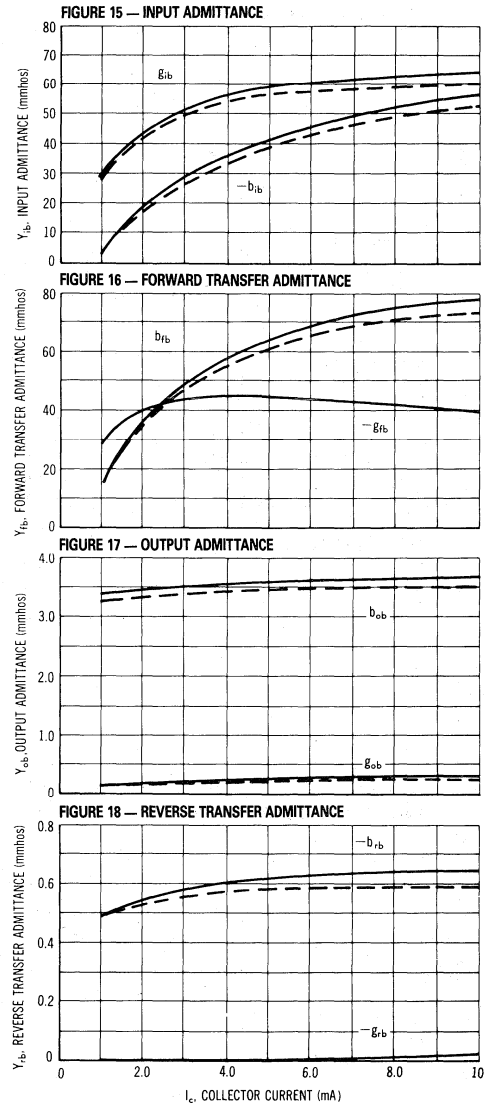


COMMON BASE Y PARAMETER VARIATIONS

Y PARAMETERS versus FREQUENCY

 $V_{CB} = 10 \text{ Vdc}$ $I_C = 2.0 \text{ mA}$ 

Y PARAMETERS versus CURRENT

 $V_{CB} = 10 \text{ Vdc}$ — $V_{CB} = 15 \text{ Vdc}$ — — $f = 450 \text{ MHz}$ 

The RF Line

PNP SILICON RF POWER TRANSISTOR

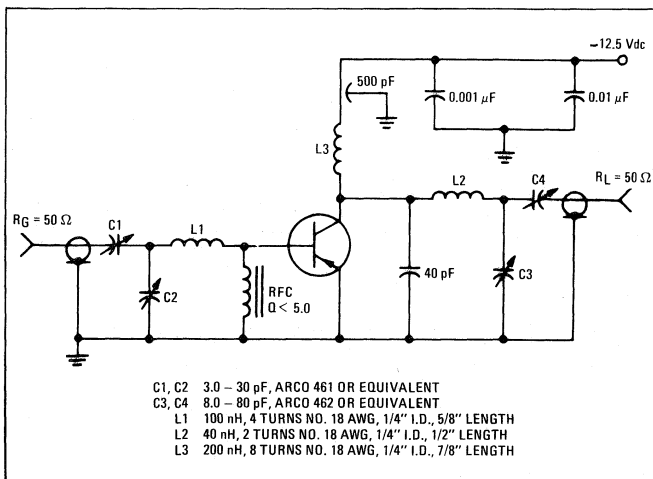
... designed for amplifier, frequency multiplier or oscillator applications in military and industrial equipment. Suitable for use as Class A, B, or C driver, or pre-driver stages in VHF applications.

- Power Output — $P_{out} = 0.5 \text{ W (Min) @ } f = 175 \text{ MHz}$
- High Current-Gain — Bandwidth Product —
 $f_T = 900 \text{ MHz (Typ) @ } I_C = 50 \text{ mAdc}$

MAXIMUM RATINGS

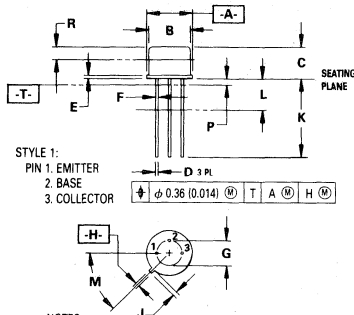
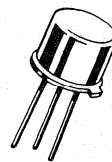
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEQ}	20	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	5.0 28.6	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

FIGURE 1 — 175 MHz OUTPUT POWER TEST CIRCUIT



MM4018

**PNP SILICON
RF POWER
TRANSISTOR**



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC 0.200 BSC			
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-04
TO-205AD
(TO-39)**

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	20	μAdc
Collector Cutoff Current ($V_{CE} = 40\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	0.1	mA
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 100\text{ MHz}$)	f_T	—	900	—	MHz
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 100\text{ kHz}$)	C_{ob}	—	3.5	—	pF
FUNCTIONAL TEST					
Power Output (Figure 1) ($P_{in} = 50\text{ mW}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	P_{out}	0.5	—	—	Watt
Collector Efficiency (Figure 1) ($P_{in} = 50\text{ mW}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	η	45	55	—	%

FIGURE 2 — POWER OUTPUT versus POWER INPUT

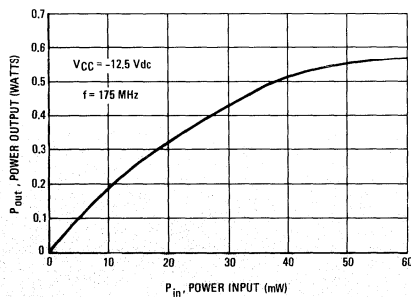


FIGURE 3 — PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

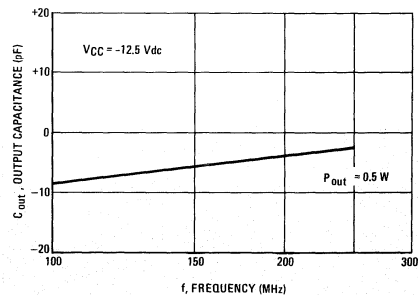


FIGURE 4 — PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

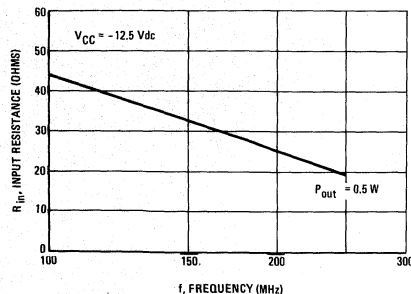
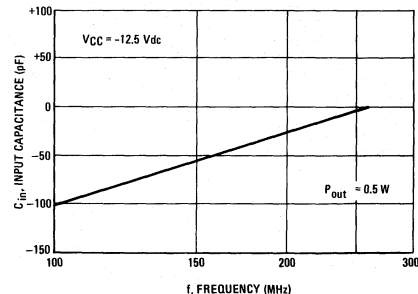


FIGURE 5 — PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY



The RF Line

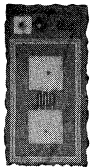



PNP SILICON HIGH-FREQUENCY TRANSISTOR

... designed for use as a high-frequency current mode switch. Because of the extremely high Current-Gain — Bandwidth this transistor also makes an excellent RF amplifier and oscillator.

- High Current-Gain — Bandwidth Product —
 $f_T = 4.0 \text{ GHz (Min) @ } I_C = 20 \text{ mAdc}$ — MM4049, MRF534
 $f_T = 5.0 \text{ GHz (Min) @ } I_C = 20 \text{ mAdc}$ — MRF536
- Low Collector-Base Capacitance —
 $C_{cb} = 1.25 \text{ pF (Max) @ } V_{CB} = 5.0 \text{ Vdc}$

MM4049
MMC4049
MRF534
MRF536

4.0 GHz @ 20 mAdc
HIGH FREQUENCY
TRANSISTOR
PNP SILICON

		MMC4049	MM4049	MRF534	MRF536	
						
		Chip	Case 20-03 TO-206AF Style 1	Case 22-03 TO-206AA Style 1	Case 317-01 Macro-X Style 2	
MAXIMUM RATINGS						
Ratings	Symbol	Values				Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	15	15	15	15	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	4.5	4.5	4.5	Vdc
Collector Current — Continuous	I_C	30	30	30	30	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	300 $T_J \text{ max} = 200^\circ\text{C}$	200 1.14	300 1.71	300 2.40	mW mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Junction	T_J, T_{stg}	-65 to +200	-65 to +200	-65 to +200	-65 to +150	$^\circ\text{C}$

MM4049, MMC4049, MRF534, MRF536

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 2.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	10	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{Adc}$, $I_E = 0$)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 25\text{ mAdc}$, $V_{CE} = 2.0\text{ Vdc}$)	h_{FE}	20	—	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product ($I_C = 20\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$, $f = 500\text{ MHz}$)	f_T	4.0 5.0	— —	— —	GHz
Collector-Base Capacitance ($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{cb}	—	—	1.3	pF
FUNCTIONAL TESTS					
Maximum Available Gain ($I_C = 15\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$, $f = 500\text{ MHz}$) ($I_C = 15\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$, $f = 500\text{ MHz}$) ($I_C = 15\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$, $f = 1.0\text{ GHz}$)	MAG	10 11.5 8.5	12 13 10	— — —	dB

FIGURE 1 — CURRENT GAIN — BANDWIDTH PRODUCT versus CURRENT

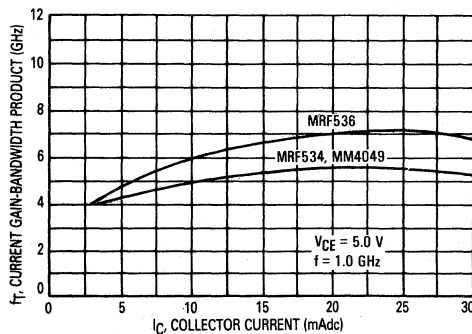


FIGURE 2 — MAXIMUM AVAILABLE GAIN versus COLLECTOR CURRENT

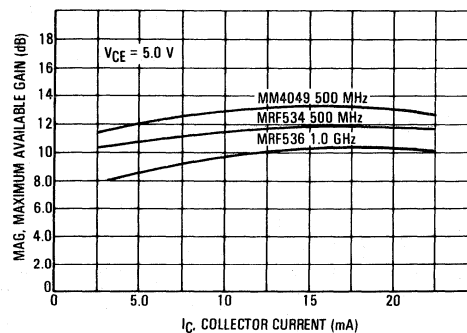
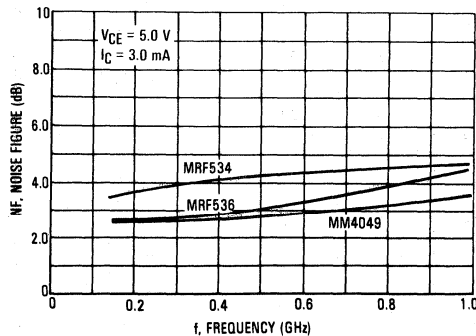


FIGURE 3 — NOISE FIGURE versus FREQUENCY



MRF534 COMMON-EMITTER S-PARAMETERS

V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
5.0	5.0	200	0.734	-22	3.70	126	0.066	66	0.507	-39
		400	0.580	-28	2.56	108	0.116	65	0.409	-48
		600	0.444	-37	2.09	95	0.158	62	0.403	-52
		800	0.400	-47	1.80	86	0.195	56	0.364	-56
		1000	0.366	-47	1.55	79	0.234	51	0.348	-69
	10	200	0.645	-27	5.36	124	0.058	69	0.394	-43
		400	0.503	-33	3.44	106	0.109	71	0.316	-52
		600	0.376	-43	2.68	93	0.153	69	0.323	-52
		800	0.333	-54	2.24	84	0.192	65	0.290	-55
		1000	0.295	-54	1.91	77	0.233	61	0.276	-71
	20	200	0.586	-28	5.90	122	0.053	70	0.338	-52
		400	0.454	-34	3.73	105	0.099	73	0.259	-60
		600	0.329	-46	2.87	93	0.143	72	0.267	-58
		800	0.289	-59	2.38	85	0.181	68	0.240	-59
		1000	0.248	-58	2.04	77	0.221	65	0.235	-75
10	5.0	200	0.752	-21	4.28	125	0.066	70	0.550	-28
		400	0.624	-26	2.77	107	0.123	68	0.495	-38
		600	0.512	-34	2.19	94	0.168	65	0.503	-44
		800	0.476	-44	1.86	86	0.207	60	0.464	-51
		1000	0.447	-45	1.60	79	0.246	55	0.443	-64
	10	200	0.685	-24	5.47	123	0.060	71	0.442	-33
		400	0.553	-28	3.46	105	0.113	71	0.385	-42
		600	0.433	-37	2.68	93	0.156	68	0.397	-46
		800	0.391	-49	2.25	85	0.194	63	0.362	-51
		1000	0.359	-47	1.92	78	0.233	59	0.342	-65
	20	200	0.621	-26	6.38	121	0.055	71	0.372	-40
		400	0.488	-31	3.97	104	0.103	72	0.316	-48
		600	0.365	-41	3.04	93	0.145	70	0.332	-50
		800	0.323	-52	2.51	85	0.182	66	0.301	-54
		1000	0.290	-50	2.13	79	0.219	63	0.288	-68

MM4049 COMMON-EMITTER S-PARAMETERS

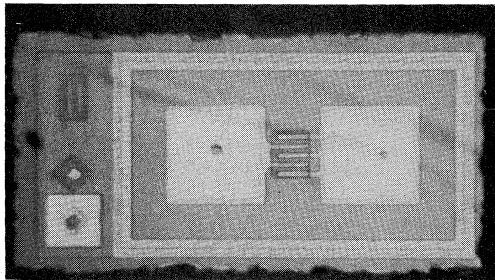
V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
5.0	5.0	200	0.634	-31	6.37	120	0.060	69	0.711	-23
		400	0.469	-34	3.95	93	0.107	65	0.602	-30
		600	0.379	-40	2.90	77	0.147	62	0.587	-33
		800	0.368	-51	2.32	65	0.183	56	0.55	-36
		1000	0.381	-54	1.93	55	0.223	50	0.528	-44
	10	200	0.523	-29	7.79	112	0.056	72	0.632	-23
		400	0.418	-28	3.74	89	0.104	68	0.543	-29
		600	0.344	-34	3.20	74	0.146	65	0.542	-32
		800	0.345	-46	2.54	64	0.184	58	0.513	-34
		1000	0.366	-50	2.09	54	0.225	52	0.493	-42
	20	200	0.454	-25	8.43	106	0.065	73	0.584	-21
		400	0.390	-23	4.67	85	0.105	70	0.513	-27
		600	0.325	-30	3.31	72	0.148	66	0.620	-30
		800	0.327	-44	2.61	62	0.188	59	0.497	-32
		1000	0.351	-48	2.15	52	0.231	52	0.476	-41
10	5.0	200	0.731	-25	5.83	121	0.053	70	0.736	-18
		400	0.589	-30	3.65	95	0.096	67	0.654	-26
		600	0.502	-38	2.71	79	0.132	64	0.645	-29
		800	0.496	-49	2.21	68	0.164	57	0.612	-33
		1000	0.499	-54	1.83	58	0.198	51	0.592	-42
	10	200	0.643	-25	7.37	114	0.051	71	0.668	-18
		400	0.542	-27	4.28	90	0.094	69	0.600	-25
		600	0.466	-34	3.10	76	0.132	65	0.603	-28
		800	0.465	-46	2.49	66	0.166	59	0.577	-31
		1000	0.476	-51	2.05	57	0.202	53	0.557	-40
	20	200	0.57	-23	8.44	109	0.049	73	0.621	-18
		400	0.496	-24	4.73	88	0.093	71	0.562	-24
		600	0.427	-31	3.38	75	0.131	67	0.572	-27
		800	0.427	-43	2.69	66	0.165	60	0.551	-30
		1000	0.445	-47	2.21	57	0.203	54	0.532	-38

MM4049, MMC4049, MRF534, MRF536

MRF536 COMMON-EMITTER S-PARAMETERS

VCE (Volts)	IC (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
5.0	5.0	400	0.401	-74	5.38	108	0.09	54	0.49	-48
		800	0.181	-102	3.03	86	0.138	51	0.35	-64
		1200	0.136	-157	2.13	70	0.181	48	0.32	-70
		1600	0.151	175	1.68	59	0.21	45	0.27	-80
		2000	0.16	148	1.44	52	0.24	41	0.269	-100
	10	400	0.289	-94	6.58	103	0.076	56	0.379	-56
		800	0.14	-137	3.55	84	0.122	55	0.266	-73
		1200	0.174	169	2.46	70	0.165	53	0.238	-77
		1600	0.196	154	1.93	60	0.196	50	0.198	-87
		2000	0.227	130	1.65	51	0.230	46	0.202	-110
	20	400	0.233	-118	7.28	99	0.066	60	0.296	-65
		800	0.163	-169	3.88	82	0.110	59	0.204	-84
		1200	0.233	156	2.65	69	0.153	57	0.179	-84
		1600	0.253	144	2.06	59	0.186	55	0.143	-96
		2000	0.290	123	1.75	50	0.220	51	0.160	-121
10	5.0	400	0.478	-54	5.14	109	0.086	58	0.535	-39
		800	0.279	-66	2.90	88	0.141	53	0.420	-55
		1200	0.166	-97	2.08	73	0.184	48	0.388	-62
		1600	0.151	-123	1.67	64	0.209	44	0.33	-72
		2000	0.110	-158	1.44	55	0.243	39	0.313	-90
	10	400	0.356	-67	6.59	105	0.075	59	0.418	-47
		800	0.182	-84	3.59	86	0.124	56	0.311	-62
		1200	0.119	-141	2.53	73	0.166	52	0.284	-67
		1600	0.131	-166	2.00	62	0.193	49	0.230	-76
		2000	0.135	154	1.72	55	0.226	45	0.222	-98
	20	400	0.26	-85	7.66	101	0.066	61	0.328	-53
		800	0.124	122	4.09	84	0.111	59	0.236	-69
		1200	0.148	172	2.83	72	0.152	56	0.216	-71
		1600	0.172	158	2.22	62	0.182	54	0.172	-80
		2000	0.201	130	1.88	54	0.214	50	0.171	-104

MMC4049 CHIP TOPOGRAPHY



Nominal Chip Size: 12 × 22 mils
 Front Metalization: Aluminum
 Back Metalization: Aluminum
 Emitter/Base Bond Pad: 4.0 × 4.0 mils
 #Emitter Fingers: 2
 #Base Fingers: 3

MM8000
MM8001

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

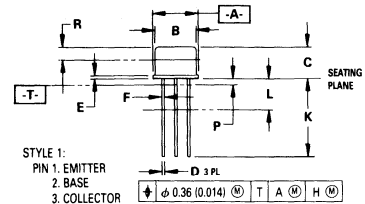
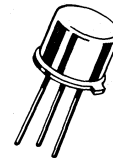
... designed for high-frequency C.A.T.V. amplifier applications. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- High Current-Gain-Bandwidth Product —
 $f_T = 900 \text{ MHz (Min) @ } I_C = 50 \text{ mAdc (MM8001)}$
- Low Output Capacitance —
 $C_{ob} = 3.5 \text{ pF (Max) @ } V_{CB} = 30 \text{ Vdc}$
- Low Noise Figure —
 $NF = 2.7 \text{ dB (Typ) @ } I_C = 10 \text{ mAdc}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current	I_C	0.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	3.5 20	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

**NPN SILICON
AMPLIFIER
TRANSISTORS**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
 4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
 5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K. MINIMUM LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	1.27		0.050	
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{CE(sus)}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	20	μAdc

ON CHARACTERISTICS

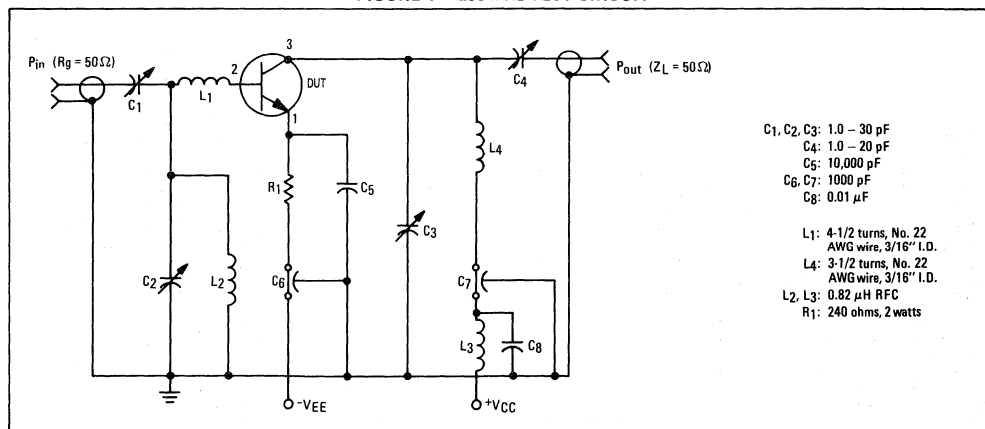
DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$)	h_{FE}	30	—	—	—
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DYNAMIC CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 25\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	MM8000 MM8001	f_T	550 700	— —	— —	MHz
($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	MM8000 MM8001		700 900	— —	— —	
($I_C = 100\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	MM8000 MM8001		700 900	— —	— —	
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)		C_{ob}	—	—	3.5	pF
Noise Figure Figure 1 ($I_C = 10\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)		NF	—	2.7	—	dB

FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain Figure 1 ($I_C = 10\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	G_{pe}	—	11.4	—	—	dB
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FIGURE 1 — 200 MHz TEST CIRCUIT

MM8009

The RF Line

NPN SILICON RF POWER TRANSISTOR

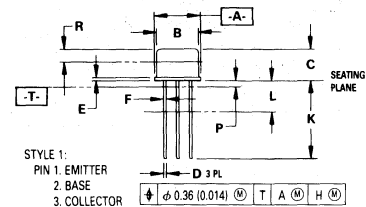
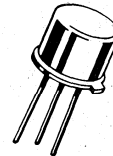
... designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output, driver, or pre-driver stages in UHF equipment and as a fundamental frequency oscillator at 1.68 GHz.

- High Output Power — $P_{out} = 0.9$ Watt (Min) @ $f = 1.0$ GHz
- High Current-Gain-Bandwidth Product —
 $f_T = 1000$ MHz (Min) @ $I_C = 50$ mAdc
- Ideal for Radiosonde Applications —
 P_{out} (Oscillator) = 300 mW (Typ) @ $f = 1.68$ GHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE}	35	Vdc
Collector-Base Voltage	V_{CB}	45	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Collector Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1.0 5.71	Watt mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	3.5 20	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$

0.9 W — 1.0 GHz
RF POWER
TRANSISTOR
NPN SILICON



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
 4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
 5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K. MINIMUM LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND. DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage ($I_C = 100\ \mu\text{A}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu\text{A}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\ \text{Vdc}$, $I_B = 0$)	I_{CEO}	—	—	100	μA
Collector Cutoff Current ($V_{CE} = 35\ \text{Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	10	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\ \text{mA}$, $V_{CE} = 5.0\ \text{Vdc}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Current-Gain-Bandwidth Product ($I_C = 50\ \text{mA}$, $V_{CE} = 15\ \text{Vdc}$, $f = 100\ \text{MHz}$)	f_T	1000	—	—	MHz
Output Capacitance ($V_{CB} = 30\ \text{Vdc}$, $I_E = 0$, $f = 1.0\ \text{MHz}$)	C_{ob}	—	2.3	3.0	pF

FUNCTIONAL TEST

Power Output (Figure 1) ($P_{in} = 316\ \text{mW}$, $V_{CE} = 28\ \text{Vdc}$, $f = 1.0\ \text{GHz}$)	P_{out}	0.9	—	—	Watt
Power Output (Oscillator) (Figure 2) ($V_{CE} = 20\ \text{Vdc}$, $V_{EB} = 1.5\ \text{Vdc}$, $f = 1.68\ \text{GHz}$) (Minimum Efficiency = 15%)	P_{out}	—	0.3	—	Watt
Collector Efficiency ($P_{in} = 316\ \text{mW}$, $V_{CE} = 28\ \text{Vdc}$, $f = 1.0\ \text{GHz}$)	η	35	—	—	%

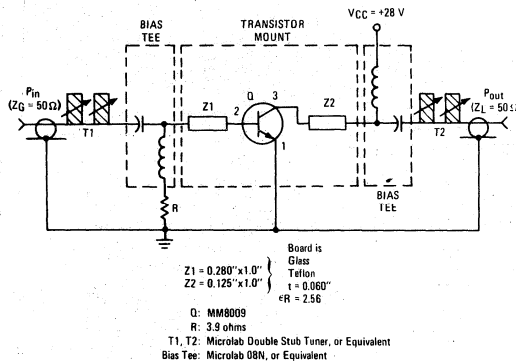
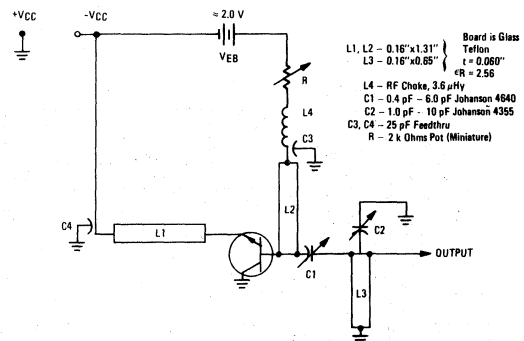
FIGURE 1 — 1.0 GHz POWER AMPLIFIER TEST CIRCUIT**FIGURE 2 — 1.68 GHz POWER OSCILLATOR TEST CIRCUIT**

FIGURE 3 – POWER OUTPUT versus POWER INPUT

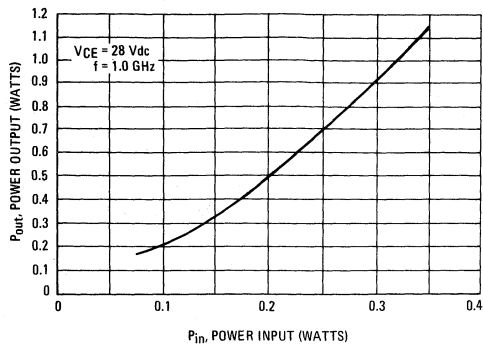


FIGURE 4 – POWER OUTPUT versus FREQUENCY

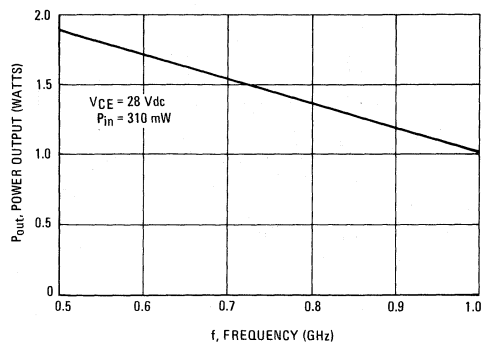


FIGURE 5 – POWER OUTPUT versus VOLTAGE

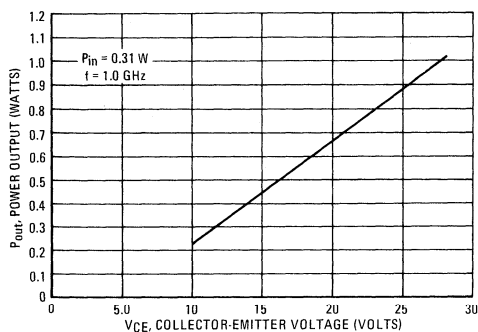


FIGURE 6 – OSCILLATOR POWER OUTPUT versus CURRENT

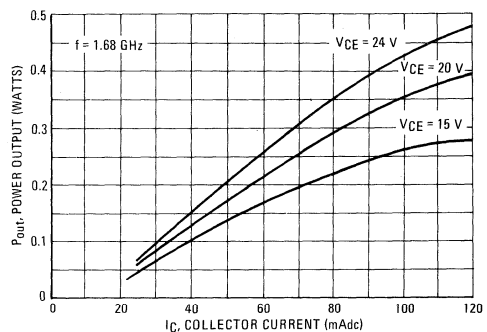


FIGURE 7 – CURRENT-GAIN-BANDWIDTH PRODUCT

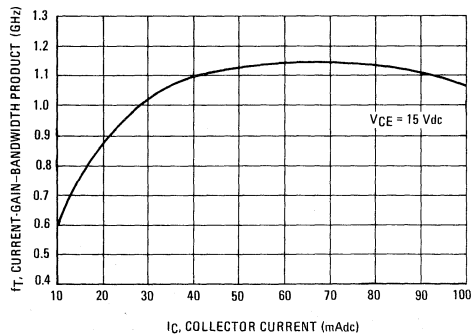
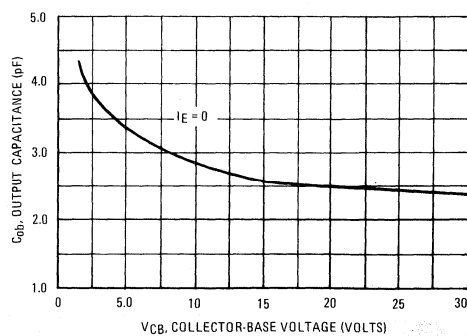


FIGURE 8 – OUTPUT CAPACITANCE versus VOLTAGE



The RF Line
NPN Silicon
High Frequency Transistors

... designed primarily for use in high-gain, low-noise, small-signal UHF and microwave amplifiers constructed with thick and thin-film circuits using surface mount components.

- High Power Gain — $G_{pe} = 12 \text{ dB Typ @ } f = 1 \text{ GHz}$
- Low Noise Figure — $NF = 1.9 \text{ dB Typ @ } f = 1 \text{ GHz}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	30	mA _{dc}
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR901 = 7A

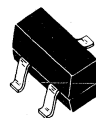
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0 \text{ mA}_{dc}, I_E = 0$)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mA}_{dc}, I_E = 0$)	$V_{(BR)CBO}$	25	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}_{dc}, I_C = 0$)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}, I_E = 0$)	I_{CBO}	—	50	nA _{dc}
ON CHARACTERISTICS				
DC Current Gain ($I_C = 5.0 \text{ mA}_{dc}, V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	30	200	—
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$)	C_{obo}	—	1.0	pF
Common-Emitter Amplifier Power Gain ($V_{CC} = 6.0 \text{ Vdc}, I_C = 5.0 \text{ mA}_{dc}, f = 1.0 \text{ GHz}$)	G_{pe}	12 (Typ)	—	dB
Noise Figure ($I_C = 5.0 \text{ mA}_{dc}, V_{CE} = 6.0 \text{ Vdc}, f = 1.0 \text{ GHz}$)	NF	—	1.9 (Typ)	dB

MMBR901

Die Source Same as MRF901

RF AMPLIFIER TRANSISTOR
NPN SILICON



CASE 318-05, STYLE 6
SOT-23

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

The RF Line NPN Silicon High Frequency Transistor

... designed for thick and thin-film circuits using surface mount components and requiring low-noise, high-gain signal amplification at frequencies to 1 GHz.

- High Gain — $G_{pe} = 15 \text{ dB Typ @ } f = 500 \text{ MHz}$
- Low Noise — $NF = 2.4 \text{ dB Typ @ } f = 500 \text{ MHz}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	35	mA _{dc}
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina $10 \times 8 \times 0.6 \text{ mm}$.

DEVICE MARKING

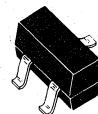
MMBR920 = 7B

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0 \text{ mA}_{dc}, I_E = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mA}_{dc}, I_E = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}_{dc}, I_C = 0$)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10 \text{ Vdc}, I_E = 0$)	I_{CBO}	—	—	50	nA _{dc}
ON CHARACTERISTICS					
DC Current Gain ($I_C = 14 \text{ mA}_{dc}, V_{CE} = 10 \text{ Vdc}$)	h_{FE}	25	—	250	—
SMALL SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 14 \text{ mA}_{dc}, V_{CE} = 10 \text{ Vdc}, f = 0.5 \text{ GHz}$)	f_T	—	4.5	—	GHz
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$)	C_{cb}	—	—	1.0	pF
Noise Figure ($I_C = 2.0 \text{ mA}_{dc}, V_{CE} = 10 \text{ Vdc}, f = 0.5 \text{ GHz}$) ($I_C = 2.0 \text{ mA}_{dc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ GHz}$)	NF	— —	2.4 3.0	— —	dB
Common-Emitter Amplifier Power Gain ($I_C = 2.0 \text{ mA}_{dc}, V_{CE} = 10 \text{ Vdc}, f = 0.5 \text{ GHz}$) ($I_C = 2.0 \text{ mA}_{dc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ GHz}$)	G_{pe}	— —	15 10	— —	dB

MMBR920

RF AMPLIFIER TRANSISTOR
NPN SILICON



CASE 318-05, STYLE 6
SOT-23

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

The RF Line NPN Silicon High Frequency Transistor

... designed for thick and thin-film circuits using surface mount components and requiring low-noise, high-gain signal amplification at frequencies to 1 GHz.

- High Gain — $G_{pe} = 11 \text{ dB Typ @ } f = 500 \text{ MHz}$
- Low Noise — $NF = 1.9 \text{ dB Typ @ } f = 500 \text{ MHz}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	35	mA _{dc}
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina $10 \times 8 \times 0.6 \text{ mm}$.

DEVICE MARKING

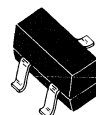
MMBR930 = 7C

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0 \text{ mA}_{dc}, I_E = 0$)	$V_{(BR)CEO}$	12	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mA}_{dc}, I_E = 0$)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}_{dc}, I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 5.0 \text{ Vdc}, I_E = 0$)	I_{CBO}	—	—	50	nA _{dc}
ON CHARACTERISTICS					
DC Current Gain ($I_C = 30 \text{ mA}_{dc}, V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	25	—	250	—
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$)	C_{cb}	—	—	1.0	pF
Noise Figure ($I_C = 2.0 \text{ mA}_{dc}, V_{CE} = 5.0 \text{ Vdc}, f = 0.5 \text{ GHz}$) ($I_C = 2.0 \text{ mA}_{dc}, V_{CE} = 5.0 \text{ Vdc}, f = 1.0 \text{ GHz}$)	NF	— —	1.9 2.5	— —	dB
Common-Emitter Amplifier Power Gain ($I_C = 2.0 \text{ mA}_{dc}, V_{CE} = 5.0 \text{ Vdc}, f = 0.5 \text{ GHz}$) ($I_C = 2.0 \text{ mA}_{dc}, V_{CE} = 5.0 \text{ Vdc}, f = 1.0 \text{ GHz}$)	G_{pe}	— —	11 8.0	— —	dB

MMBR930

AMPLIFIER TRANSISTOR
NPN SILICON



CASE 318-05, STYLE 6
SOT-23
(TO-236AA/AB)

The RF Line

NPN Silicon
High Frequency Transistor

... designed primarily for use in low-power amplifiers to 1 GHz. Ideal for pagers and other battery operated systems where power consumption is critical.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	5.0	Vdc
Collector-Base Voltage	V_{CBO}	10	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	5.0	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	50 0.4	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	2500	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR931 = 7D

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	$V_{(BR)CEO}$	5.0	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.01$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	10	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 5.0$ Vdc, $I_E = 0$)	I_{CBO}	—	—	50	nAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 0.25$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	30	—	150	—
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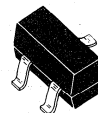
SMALL-SIGNAL CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 1.0$ Vdc, $I_E = 0$, $f = 1.0$ MHz)	C_{cb}	—	—	0.5	pF
Noise Figure ($I_E = 0.25$ mAdc, $V_{CE} = 1.0$ Vdc, $f = 1.0$ GHz)	NF	—	4.3	—	dB
Power Gain at Optimum Noise Figure ($I_E = 0.25$ mAdc, $V_{CE} = 1.0$ Vdc, $f = 1.0$ GHz)	GNF	—	10	—	—

MMBR931

Die Source Same as MRF931

RF AMPLIFIER TRANSISTOR
NPN SILICON



CASE 318-05, STYLE 6
SOT-23
(TO-236AA/AB)

MMBR2060

The RF Line
NPN Silicon
High Frequency Transistor

... designed primarily for use in high-gain, low-noise amplifier, oscillator and mixer applications. Packaged for thick or thin-film circuits using surface mount components.

RF AMPLIFIER TRANSISTOR
NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	14	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	50	mA _{dc}
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

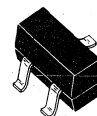
*Package mounted on 99.5% alumina $10 \times 8 \times 0.6$ mm.

DEVICE MARKING

MMBR2060 = 7E

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mA _{dc} , $I_B = 0$)	$V_{(BR)CEO}$	14	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc, $I_E = 0$)	I_{CBO}	—	50	nA _{dc}
Emitter Cutoff Current ($V_{EB} = 4.0$, $I_C = 0$)	I_{EBO}	—	100	μA _{dc}
ON CHARACTERISTICS				
DC Current Gain ($I_C = 5.0$ mA _{dc} , $V_{CE} = 5.0$ Vdc)	h_{FE}	20	—	—
Collector-Emitter Saturation Voltage ($I_C = 80$ mA _{dc} , $I_B = 8.0$ mA _{dc})	$V_{CE(sat)}$	—	0.38	Vdc
Base-Emitter Saturation Voltage ($I_C = 40$ mA _{dc} , $I_B = 20$ mA _{dc})	$V_{BE(sat)}$	—	0.98	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 20$ mA _{dc} , $V_{CE} = 1.0$ Vdc, $f = 100$ MHz)	f_T	1.0 (Typ)	—	GHz
Small-Signal Current Gain ($I_C = 20$ mA _{dc} , $V_{CE} = 10$ Vdc, $f = 500$ MHz)	h_{FE}	2.0	—	—
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$)	C_{cb}	—	1.0	pF
Emitter-Base Capacitance ($V_{EB} = 0.5$ Vdc, $I_C = 0$)	C_{eb}	—	3.0	pF
Noise Figure ($V_{CE} = 10$ Vdc, $I_E = 1.5$ mA _{dc} , $f = 450$ MHz)	NF	—	3.5 (Typ)	dB
Common-Emitter Amplifier Power Gain ($V_{CE} = 10$ Vdc, $I_E = 1.5$ mA _{dc} , $f = 450$ MHz)	G_{pe}	12.5 (Typ)	—	dB



CASE 318-05, STYLE 6
SOT-23
(TO-236AA/AB)

The RF Line

**NPN Silicon
High Frequency Transistor**

... designed primarily for use in high-gain, low-noise amplifier, oscillator and mixer applications. Packaged for thick or thin-film circuits using surface mount components.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Collector-Emitter Voltage	V_{CES}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	40	mA dc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR2857 = 7K

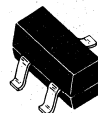
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 3.0 \text{ mA dc}, I_B = 0$)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1.0 \mu\text{A dc}, I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 3.0 \text{ mA dc}, I_E = 0$)	$V_{(BR)CES}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu\text{A dc}, I_C = 0$)	$V_{(BR)EBO}$	2.5	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}, I_E = 0$)	I_{CBO}	—	0.05	$\mu\text{A dc}$
ON CHARACTERISTICS				
DC Current Gain ($I_C = 3.0 \text{ mA dc}, V_{CE} = 1.0 \text{ Vdc}$)	h_{FE}	30	—	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain-Bandwidth Product ($I_C = 4.0 \text{ mA dc}, V_{CE} = 10 \text{ Vdc}, f = 100 \text{ MHz}$)	f_T	1000 (Typ)	—	MHz
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 0.1 \text{ MHz}$)	C_{cb}	—	1.0	pF
Small-Signal Current Gain ($I_C = 2.0 \text{ mA dc}, V_{CE} = 6.0 \text{ Vdc}, f = 1.0 \text{ kHz}$)	h_{fe}	50	—	—
Noise Figure ($I_C = 1.5 \text{ mA dc}, V_{CE} = 6.0 \text{ Vdc}, R_S = 50 \Omega, f = 450 \text{ MHz}$)	NF	—	4.5 (Typ)	dB
Common-Emitter Amplifier Power Gain ($I_C = 1.5 \text{ mA dc}, V_{CE} = 6.0 \text{ Vdc}, f = 450 \text{ MHz}$)	G_{pE}	12.5 (Typ)	—	dB

MMBR2857

Die Source Same as 2N2857

**RF AMPLIFIER TRANSISTOR
NPN SILICON**



**CASE 318-05, STYLE 6
SOT-23
(TO-236AA/AB)**

The RF Line
PNP Silicon
High Frequency Transistor

... designed for high-gain, low-noise amplifier oscillator and mixer applications. Specifically packaged for thick and thin-film circuits using surface mount components.

- High Gain — $G_{pe} = 17 \text{ dB Typ @ } f = 450 \text{ MHz}$
- Low Noise — $NF = 3 \text{ dB Typ @ } f = 450 \text{ MHz}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	30	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina $10 \times 8 \times 0.6 \text{ mm}$.

DEVICE MARKING

MMBR4957 = 7F

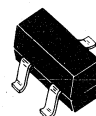
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0 \text{ mAdc}, I_B = 0$)	$V_{(BR)CEO}$	30	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu\text{Adc}, I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu\text{Adc}, I_C = 0$)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 10 \text{ Vdc}, I_C = 0$)	I_{CBO}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 2.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}$)	h_{FE}	20	150	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_E = 2.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 100 \text{ MHz}$)	f_T	1,200 (Typ)	—	MHz
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1.0 \text{ MHz}$)	C_{cb}	—	0.8	pF
Common-Emitter Amplifier Power Gain ($V_{CE} = 10 \text{ Vdc}, I_C = 2.0 \text{ mAdc}, f = 450 \text{ MHz}$)	G_{pe}	17 (Typ)	—	dB
Noise Figure ($I_C = 2.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 450 \text{ MHz}$)	NF	—	3.0 (Typ)	dB

MMBR4957

Die Source Same as 2N4957

RF AMPLIFIER TRANSISTOR
PNP SILICON



CASE 318-05, STYLE 6
SOT-23
(TO-236AA/AB)

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

The RF Line NPN Silicon High Frequency Transistor

... designed for thick and thin-film circuits using surface mount components and requiring low-noise, high-gain signal amplification at frequencies to 1 GHz.

- High Gain — $G_{pe} = 17 \text{ dB Typ @ } f = 450 \text{ MHz}$
- Low Noise — $NF = 2.5 \text{ dB Typ @ } f = 450 \text{ MHz}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	mA _{dc}
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W

*Package mounted on 99.5% alumina $10 \times 8 \times 0.6 \text{ mm}$.

DEVICE MARKING

MMBR5031 = 7G

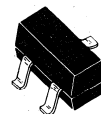
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0 \text{ mA}_{dc}, I_B = 0$)	$V_{(BR)CEO}$	10	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.01 \text{ mA}_{dc}, I_E = 0$)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.01 \text{ mA}_{dc}, I_C = 0$)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 6.0 \text{ Vdc}, I_E = 0$)	I_{CBO}	—	10	nA _{dc}
ON CHARACTERISTICS				
DC Current Gain ($I_C = 1.0 \text{ mA}_{dc}, V_{CE} = 6.0 \text{ Vdc}$)	h_{FE}	25	300	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 5.0 \text{ mA}_{dc}, V_{CE} = 6.0 \text{ Vdc}, f = 100 \text{ MHz}$)	f_T	1,000 (Typ)	—	MHz
Collector-Base Capacitance ($V_{CE} = 6.0 \text{ Vdc}, I_E = 0, f = 0.1 \text{ MHz}$)	C_{cb}	—	1.5	pF
Noise Figure ($I_C = 1.0 \text{ mA}_{dc}, V_{CE} = 6.0 \text{ Vdc}, f = 450 \text{ MHz}$)	NF	—	2.5 (Typ)	dB
Common-Emitter Amplifier Power Gain ($I_C = 1.0 \text{ mA}_{dc}, V_{CE} = 6.0 \text{ Vdc}, f = 450 \text{ MHz}$)	G_{pe}	17 (Typ)	25	dB

MMBR5031

Die Source Same as 2N5031

RF AMPLIFIER TRANSISTOR
NPN SILICON



CASE 318-05, STYLE 6
SOT-23
(TO-236AA/AB)

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

The RF Line NPN Silicon High Frequency Transistor

... designed for small-signal amplification at frequencies to 500 MHz. Specifically packaged for use in thick and thin-film circuits using surface mount components.

- High Gain — $G_{pe} = 15 \text{ dB Typ @ } f = 200 \text{ MHz}$
- Low Noise — $NF = 4.5 \text{ dB Typ @ } f = 200 \text{ MHz}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	50	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina $10 \times 8 \times 0.6 \text{ mm}$.

DEVICE MARKING

MMBR5179 = 7H

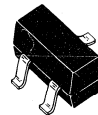
ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 3.0 \text{ mAdc}, I_B = 0$)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.01 \text{ mAdc}, I_E = 0$)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.01 \text{ mAdc}, I_C = 0$)	$V_{(BR)EBO}$	2.5	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}, I_E = 0$)	I_{CBO}	—	0.02	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 3.0 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$)	h_{FE}	25	—	—
Collector-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc}$)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc}$)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 5.0 \text{ mAdc}, V_{CE} = 6.0 \text{ Vdc}, f = 100 \text{ MHz}$)	f_T	900 (Typ)	—	MHz
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 0.1 \text{ to } 1.0 \text{ MHz}$)	C_{cb}	—	1.0	pF
Small Signal Current Gain ($I_C = 2.0 \text{ mAdc}, V_{CE} = 6.0 \text{ Vdc}, f = 1.0 \text{ kHz}$)	h_{fe}	25	—	—
Noise Figure ($I_C = 1.5 \text{ mAdc}, V_{CE} = 6.0 \text{ Vdc}, R_S = 50 \Omega, f = 200 \text{ MHz}$)	NF	—	4.5 (Typ)	dB
Common-Emitter Amplifier Power Gain ($V_{CE} = 6.0 \text{ Vdc}, I_C = 5.0 \text{ mAdc}, f = 200 \text{ MHz}$)	G_{pe}	15 (Typ)	—	dB

MMBR5179

Die Source Same as 2N5179

RF AMPLIFIER TRANSISTOR
NPN SILICON



CASE 318-05, STYLE 6
SOT-23
(TO-236AA/AB)

The RF Line

PNP Silicon

High Frequency Transistor

... this high current gain-bandwidth transistor makes an excellent RF amplifier and oscillator. It is available in the surface mount SOT-23 low cost plastic package.

- High Current Gain-Bandwidth Product
 $f_T = 5.5 \text{ GHz (Typ) @ } I_C = 20 \text{ mA}$
- High Gain
 $G_{NF} = 14 \text{ dB (Typ) @ } 10 \text{ mA/500 MHz}$
- Low Collector-Base Capacitance
 $C_{cb} = 0.8 \text{ pF (Typ) @ } V_{CB} = 5 \text{ Vdc}$
- Tape and Reel Packaging Options

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	30	mA
Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate Above 25°C	P_D	200* 1.6	mW mW/ $^\circ\text{C}$
Storage Temperature	T_{stg}	-65 to +150	$^\circ\text{C}$

*Free air

DEVICE MARKING

MMBR536 = 7R

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 2 \text{ mA}, I_B = 0$)	$V_{(BR)CEO}$	10	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu\text{A}, I_E = 0$)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \mu\text{A}, I_C = 0$)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10 \text{ Vdc}, I_E = 0$)	I_{CBO}	—	—	10	nAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 20 \text{ mA}, V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	200	—
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DYNAMIC CHARACTERISTICS

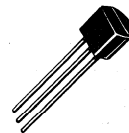
Current Gain-Bandwidth Product ($I_C = 20 \text{ mAdc}, V_{CE} = 5 \text{ Vdc}, f = 1 \text{ GHz}$)	f_T	—	5.5	—	GHz
Collector-Base Capacitance ($V_{CB} = 5 \text{ Vdc}, I_F = 0, f = 1 \text{ MHz}$)	C_{cb}	—	0.8	1.2	pF

FUNCTIONAL TESTS

Gain @ Noise Figure ($I_C = 10 \text{ mAdc}, V_{CE} = 5 \text{ Vdc}$)	$f = 500 \text{ MHz}$ $f = 1 \text{ GHz}$	G_{NF}	— —	14 8	— —	dB
Noise Figure ($I_C = 10 \text{ mAdc}, V_{CE} = 5 \text{ Vdc}$)	$f = 500 \text{ MHz}$ $f = 1 \text{ GHz}$	NF	— —	4.5 6	— —	dB

MPS536
MMBR536

LOW NOISE
HIGH RF GAIN



CASE 29-04, STYLE 2
TO-226AA
(TO-92)
MPS536



CASE 318-05, STYLE 6
SOT-23
MMBR536

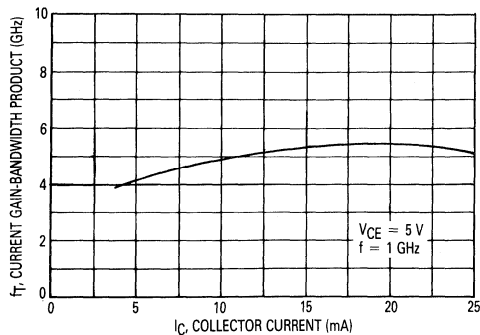


Figure 1. Current Gain-Bandwidth Product versus Collector Current

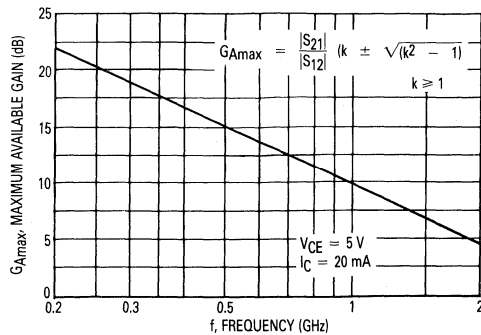


Figure 2. Maximum Available Gain (G_{Amix}) versus Frequency

SOT-23

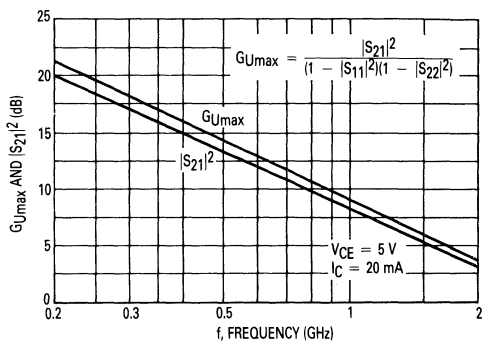


Figure 3. Maximum Unilateral Gain (G_{Umax}) and Insertion Gain ($|S_{21}|^2$) versus Frequency

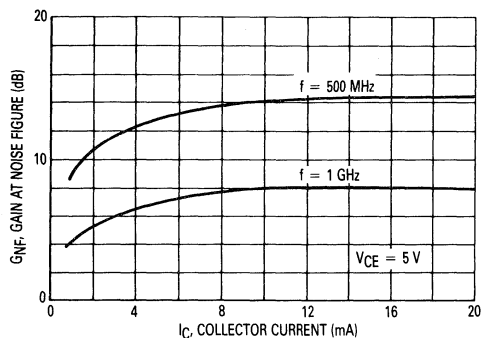


Figure 4. Gain at Noise Figure versus Collector Current

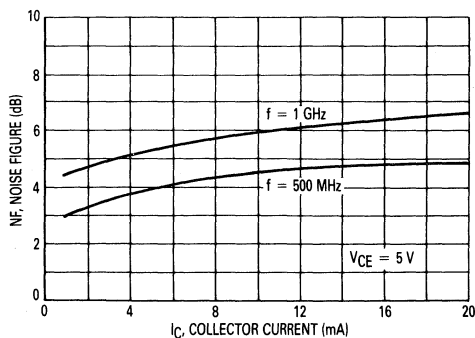


Figure 5. Noise Figure versus Collector Current

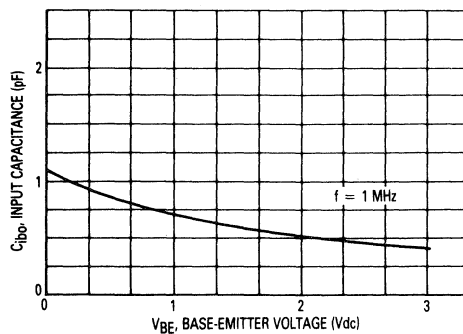


Figure 6. Input Capacitance versus Emitter-Base Voltage

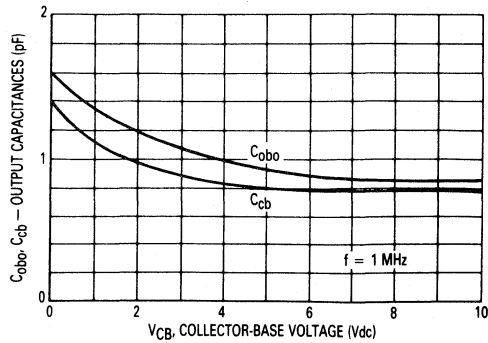
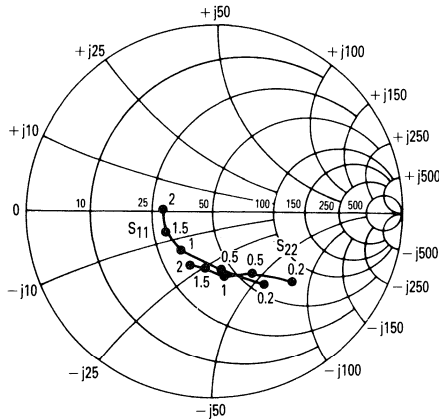
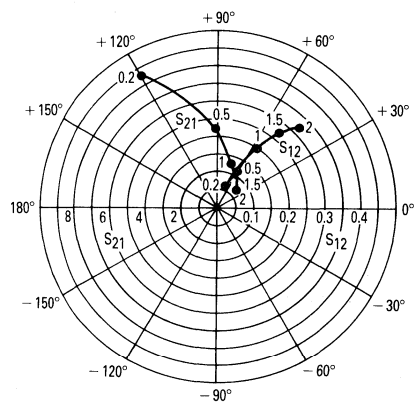


Figure 7. Output Capacitance versus Collector-Base Voltage

INPUT/OUTPUT REFLECTION COEFFICIENTS
versus
FREQUENCY
 $V_{CE} = 10\text{ V}, I_C = 10\text{ mA}$



FORWARD AND REVERSE TRANSMISSION COEFFICIENTS
versus
FREQUENCY
 $V_{CE} = 10\text{ V}, I_C = 10\text{ mA}$



COMMON EMITTER S-PARAMETERS

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
10	5	200	0.60	-44	6.47	126	0.07	66	0.68	-35
		500	0.37	-70	3.57	97	0.14	60	0.48	-50
		1000	0.27	-105	2.16	74	0.22	53	0.40	-69
		1500	0.24	-138	1.62	58	0.29	46	0.37	-87
		2000	0.22	-166	1.38	44	0.33	42	0.34	-103
	10	200	0.48	-54	8.65	120	0.06	66	0.58	-40
		500	0.30	-82	4.32	94	0.12	62	0.38	-58
		1000	0.24	-122	2.52	74	0.20	57	0.32	-78
		1500	0.24	-155	1.84	59	0.27	51	0.30	-96
		2000	0.24	178	1.54	46	0.32	47	0.28	-112
	20	200	0.39	-63	10.10	115	0.06	67	0.49	-50
		500	0.25	-94	4.77	91	0.11	65	0.32	-65
		1000	0.24	-136	2.72	73	0.19	60	0.27	-84
		1500	0.24	-167	1.96	58	0.26	54	0.26	-102
		2000	0.26	168	1.63	46	0.32	50	0.25	-119

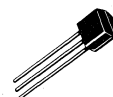
The RF Line NPN Silicon High Frequency Transistors

... designed for low noise, wide dynamic range front-end amplifiers and low-noise VCO's. Available in a surface-mountable plastic package, as well as the popular TO-226AA (TO-92) package. This Motorola series of small-signal plastic transistors offers superior quality and performance at low cost.

- High Gain-Bandwidth Product
 $f_T = 8 \text{ GHz (Typ) @ 50 mA}$
- Low Noise Figure
 $NF = 2 \text{ dB (Typ) @ 500 MHz}$
- High Gain
 $G_{NF} = 17 \text{ dB (Typ) @ 30 mA/500 MHz}$
- State-of-the-Art Technology
 Fine Line Geometry
 Ion-Implanted Arsenic Emitters
 Gold Top Metallization and Wires
 Silicon Nitride Passivation
- Tape and Reel Packaging Options

MPS571
MMBR571

LOW NOISE
HIGH RF GAIN



CASE 29-04, STYLE 2
TO-226AA
(TO-92)
MPS571



CASE 318-05, STYLE 6
SOT-23
MMBR571

MAXIMUM RATINGS

Ratings	Symbol	MPS571	MMBR571	Unit
Collector-Emitter Voltage	V_{CEO}	10		Vdc
Collector-Base Voltage	V_{CBO}	20		Vdc
Emitter-Base Voltage	V_{EBO}	3		Vdc
Collector Current — Continuous	I_C	80		mA
Power Dissipation @ $T_A = 25^\circ\text{C}$	P_D	625	200 (Free Air)	mW
Storage Temperature	T_{stg}	- 55 to + 150		$^\circ\text{C}$

DEVICE MARKING

MMBR571 = 7X

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1 mA, I _B = 0)	V _{(BR)CEO}	10	12	—	Vdc
Collector-Base Breakdown Voltage (I _C = 0.1 mA, I _E = 0)	V _{(BR)CBO}	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 50 μAdc, I _C = 0)	V _{(BR)EBO}	2.5	—	—	Vdc
Collector Cutoff Current (V _{CB} = 8 Vdc, I _E = 0)	I _{CBO}	—	—	10	μAdc

ON CHARACTERISTICS

DC Current Gain (I _C = 30 mAdc, V _{CE} = 5 Vdc)	h _{FE}	50	—	300	—
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DYNAMIC CHARACTERISTICS

Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1 MHz)	C _{cb}	—	0.7	1	pF
Current Gain-Bandwidth Product (V _{CE} = 5 Vdc, I _C = 50 mAdc, f = 1 GHz) MPS571 MMBR571	f _T	— —	6 8	— —	GHz

FUNCTIONAL TESTS

Gain @ Noise Figure (I _C = 10 mAdc, V _{CE} = 5 Vdc)	MPS571 f = 0.5 GHz f = 1 GHz MMBR571 f = 0.5 GHz f = 1 GHz	G _{NF}	— — — —	14 9 16.5 10.5	— — — —	dB
Noise Figure (I _C = 10 mAdc, V _{CE} = 5 Vdc)	MPS571 f = 0.5 GHz f = 1 GHz MMBR571 f = 0.5 GHz f = 1 GHz	NF	— — — —	2 2.6 2 2.6	— — — —	dB

Figure 1. Maximum Available Gain versus Frequency

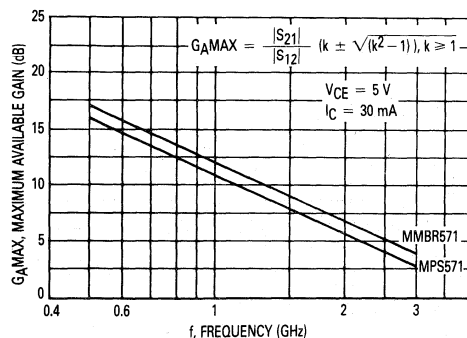


Figure 2. Current Gain-Bandwidth versus Collector Current @ 1 GHz

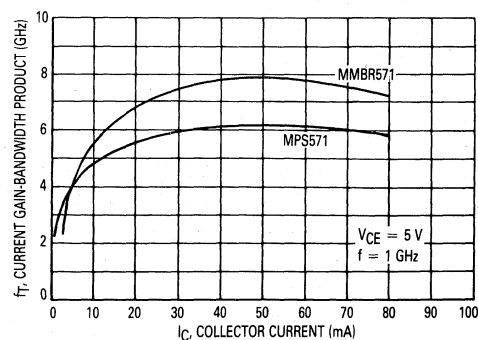


Figure 3. Input Capacitance versus
Emitter Base Voltage

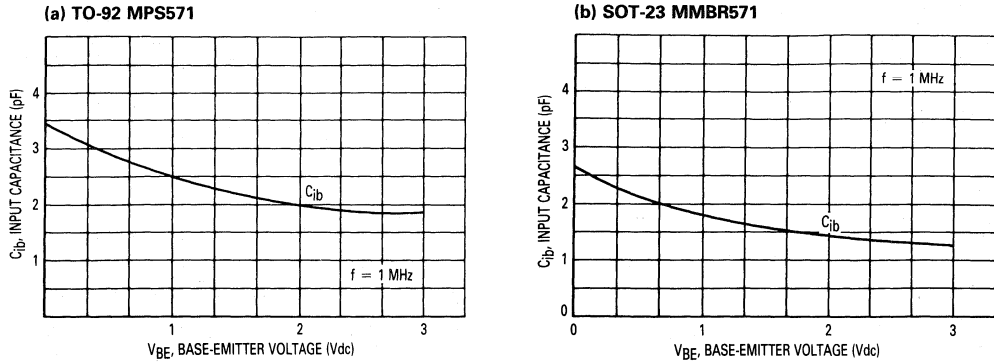


Figure 4. Output Capacitances versus
Collector-Base Voltage

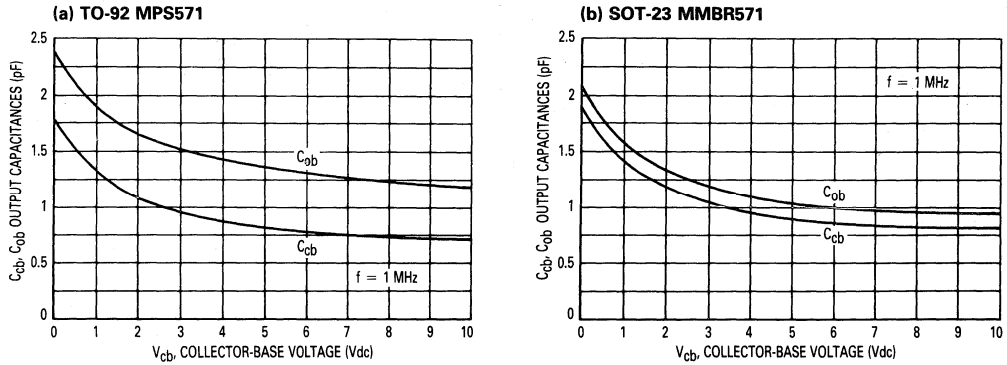


Figure 5. Gain at Noise Figure versus
Collector Current

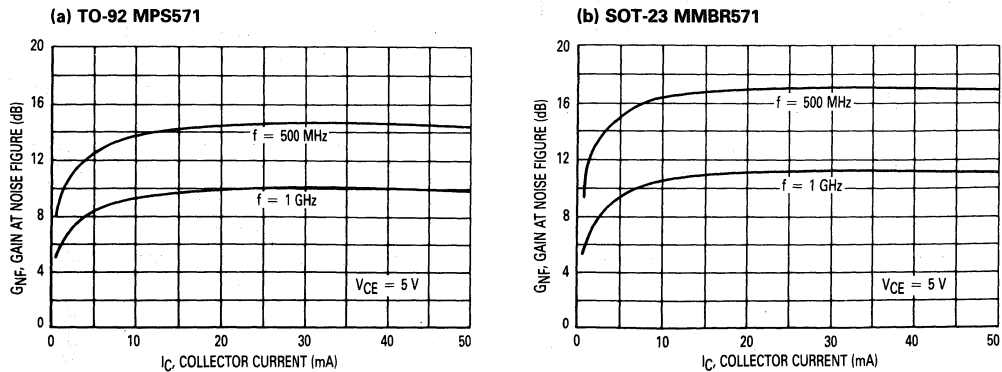


Figure 6. Noise Figure versus Collector Current

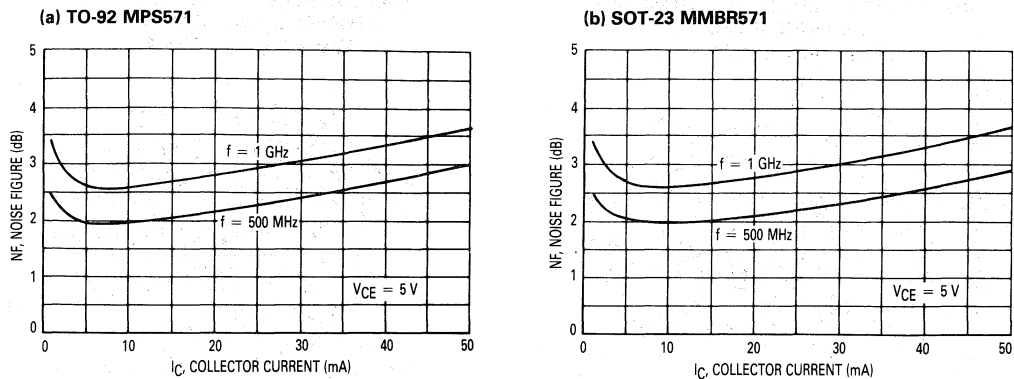


Figure 7. Gain at Noise Figure and Noise Figure versus Frequency

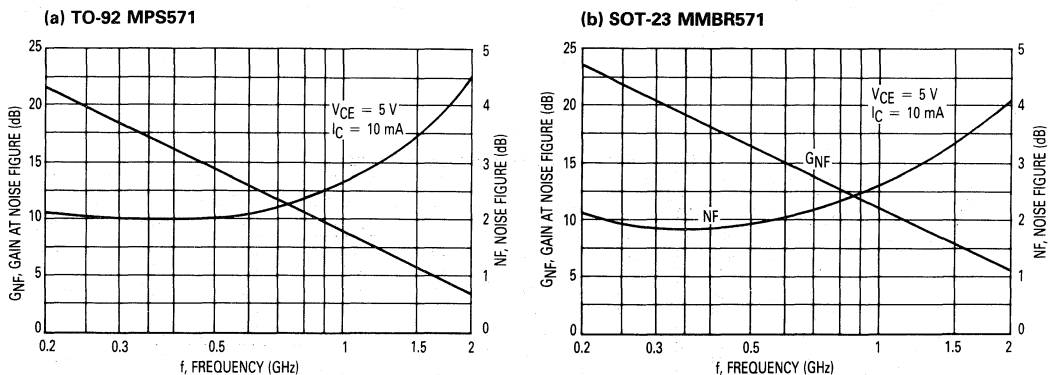
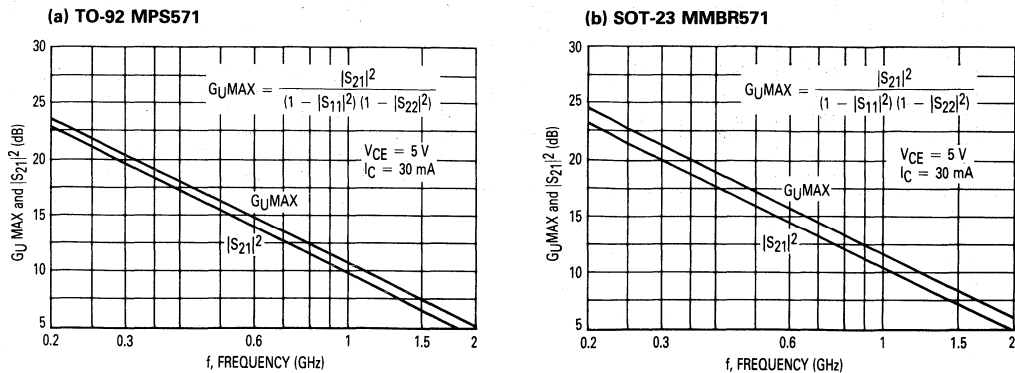
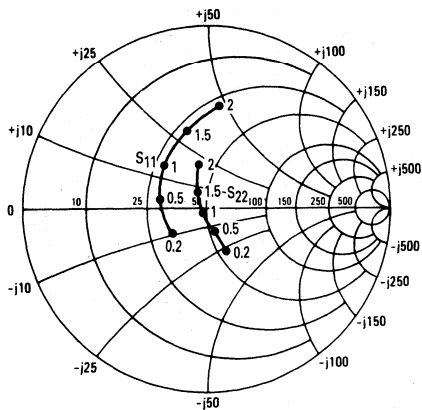


Figure 8. Maximum Unilateral Gain and Insertion Gain versus Frequency

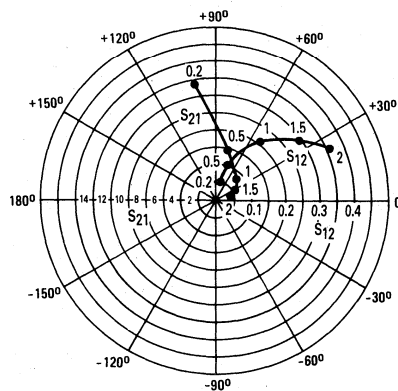


TO-92 MPS571

INPUT/OUTPUT REFLECTION COEFFICIENTS
versus FREQUENCY
 $V_{CE} = 5 \text{ V}$, $I_C = 30 \text{ mA}$



FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY
 $V_{CE} = 5 \text{ V}$, $I_C = 30 \text{ mA}$

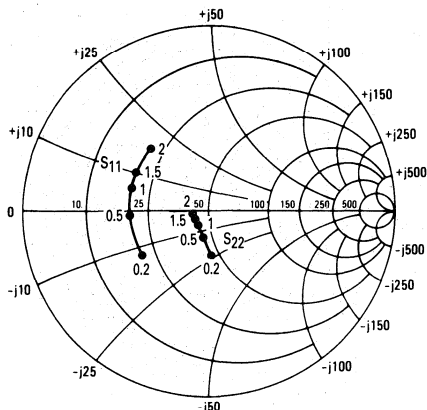


COMMON EMITTER S-PARAMETERS

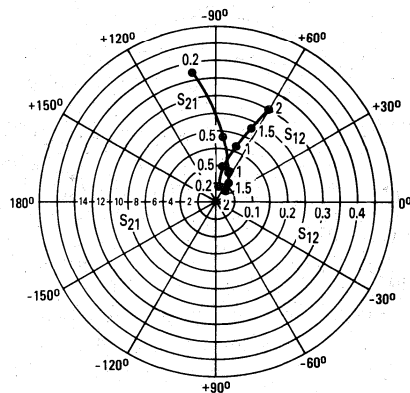
VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
5	5	200	0.62	-80	8.22	122	0.07	56	0.63	-44
		500	0.40	-148	4.52	87	0.11	50	0.36	-58
		1000	0.39	155	2.51	54	0.16	48	0.23	-78
		1500	0.46	122	1.86	32	0.23	42	0.15	-114
		2000	0.59	100	1.50	14	0.31	33	0.14	173
	15	200	0.33	-121	12.88	105	0.05	67	0.37	-59
		500	0.28	-175	5.62	79	0.10	65	0.18	-67
		1000	0.32	143	2.99	53	0.19	55	0.08	-94
		1500	0.40	117	2.14	32	0.27	42	0.07	171
		2000	0.55	95	1.74	17	0.35	30	0.198	117
	30	200	0.23	-143	13.65	99	0.05	75	0.26	-62
		500	0.23	169	5.75	76	0.11	70	0.13	-68
		1000	0.30	130	3.05	50	0.21	55	0.04	-136
		1500	0.41	106	2.11	28	0.29	38	0.12	130
		2000	0.56	85	1.70	11	0.36	23	0.26	102
	50	200	0.21	-158	13.96	96	0.05	79	0.21	-61
		500	0.23	162	5.82	75	0.11	72	0.11	-66
		1000	0.30	128	3.09	49	0.21	56	0.03	-149
		1500	0.41	105	2.11	28	0.29	39	0.12	127
		2000	0.56	84	1.70	11	0.36	23	0.27	100

SOT-23 MMBR571

INPUT/OUTPUT REFLECTION COEFFICIENTS
versus FREQUENCY
 $V_{CE} = 5 \text{ V}$, $I_C = 30 \text{ mA}$



FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY
 $V_{CE} = 5 \text{ V}$, $I_C = 30 \text{ mA}$



COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle \phi$	$|S_{21}|$	$\angle \phi$	$|S_{12}|$	$\angle \phi$	$|S_{22}|$	$\angle \phi$
5	5	200	0.68	-82	8.41	126	0.07	53	0.61	-45
		500	0.52	-142	4.62	93	0.10	46	0.35	-60
		1000	0.50	179	2.57	72	0.14	53	0.26	-71
		1500	0.51	161	1.82	57	0.19	58	0.24	-77
		2000	0.52	143	1.48	45	0.24	59	0.22	-86
	15	200	0.46	-125	13.65	108	0.05	60	0.35	-73
		500	0.43	-169	6.03	86	0.09	66	0.17	-94
		1000	0.44	168	3.20	72	0.16	67	0.14	-111
		1500	0.45	152	2.21	58	0.22	64	0.11	-118
		2000	0.46	137	1.80	48	0.29	59	0.10	-131
	30	200	0.42	-148	14.79	102	0.04	68	0.26	-87
		500	0.41	-177	6.31	84	0.09	72	0.14	-115
		1000	0.42	165	3.35	71	0.16	70	0.12	-135
		1500	0.44	151	2.29	59	0.23	65	0.11	-144
		2000	0.44	135	1.84	48	0.30	60	0.10	-157
	50	200	0.41	-159	15.14	98	0.04	73	0.21	-96
		500	0.42	179	6.38	83	0.09	75	0.13	-124
		1000	0.43	163	3.35	70	0.16	71	0.12	-143
		1500	0.44	148	2.32	58	0.23	66	0.10	-151
		2000	0.45	134	1.84	48	0.30	60	0.09	-163

MPS901
MPS1983

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

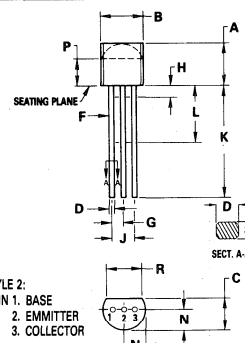
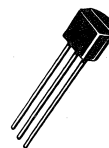
... designed primarily for use in high-gain, low-noise small-signal amplifiers.

- High Current-Gain-Bandwidth Product — $f_T = 4.5 \text{ GHz}$ (Typ) @ $I_C = 15 \text{ mA}$
- High Power Gain — $G_{pe} = 12 \text{ dB}$ (Typ) @ $f = 900 \text{ MHz}$
- Low Noise Figure — $NF = 2.4 \text{ dB}$ (Typ) @ $f = 900 \text{ MHz}$
- Low Feedback Capacitance — $C_{cb} = 0.5 \text{ pF}$ (Typ) @ $V_{cb} = 10 \text{ V}$
- Die Source Same as MRF901

2.4 dB @ 900 MHz

HIGH FREQUENCY TRANSISTOR

NPN SILICON



STYLE 2:
 PIN 1. BASE
 2. EMITTER
 3. COLLECTOR

- NOTES:
1. CONTOUR OF PACKAGE BEYOND ZONE "P" IS UNCONTROLLED.
 2. DIM "F" APPLIES BETWEEN "H" AND "L". DIM "D" & "S" APPLIES BETWEEN "L" & 12.70mm (0.5") FROM SEATING PLANE. LEAD DIM IS UNCONTROLLED IN "H" & BEYOND 12.70mm (0.5") FROM SEATING PLANE.
 3. CONTROLLING DIM: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.32	5.33	0.170	0.210
B	4.45	5.20	0.175	0.205
C	3.18	4.19	0.125	0.165
D	0.41	0.55	0.016	0.022
F	0.41	0.48	0.016	0.019
G	1.15	1.39	0.045	0.055
H	—	2.54	—	0.100
J	2.42	2.66	0.095	0.105
K	12.70	—	0.500	—
L	6.35	—	0.250	—
N	2.04	2.66	0.080	0.105
P	2.93	—	0.115	—
R	3.43	—	0.135	—
S	0.39	0.50	0.015	0.020

CASE 29-04
TO-226AA
(TO-92)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	30	mA
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	300 3.0	mW mW/°C
Operating Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mA, I _B = 0)	V _{(BR)CEO}	15	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 0.1 mA, I _E = 0)	V _{(BR)CBO}	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 0.1 mA, I _C = 0)	V _{(BR)EBO}	2.0	—	—	Vdc
Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0)	I _{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I _C = 10 mA, V _{CE} = 10 Vdc)	h _{FE}	30	80	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product (I _C = 15 mA, V _{CE} = 10 Vdc, f = 1.0 GHz)	f _T	—	4.5	—	GHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	C _{cb}	—	0.5	1.0	pF
Noise Figure (Figure 1) (I _C = 5.0 mA, V _{CE} = 10 Vdc, f = 900 MHz)	NF	—	2.4	—	dB
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (Figure 1) (I _C = 10 mA, V _{CE} = 10 Vdc, f = 900 MHz)	G _{pe}	—	12	—	dB

FIGURE 1 — 900 MHz TEST CIRCUIT SCHEMATIC

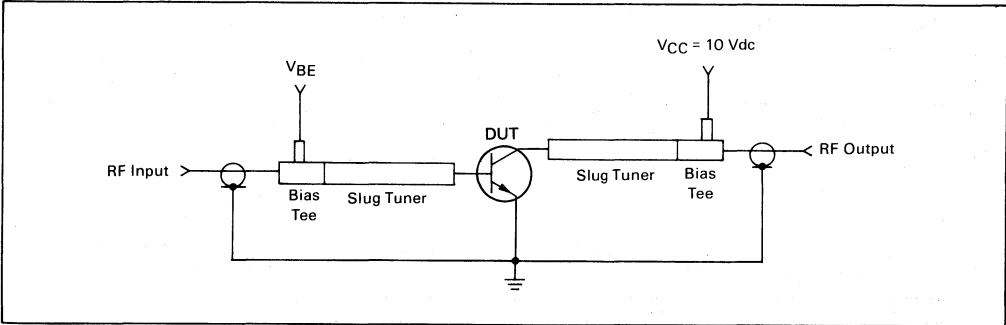


FIGURE 2 — CURRENT GAIN-BANDWIDTH PRODUCT
versus COLLECTOR CURRENT

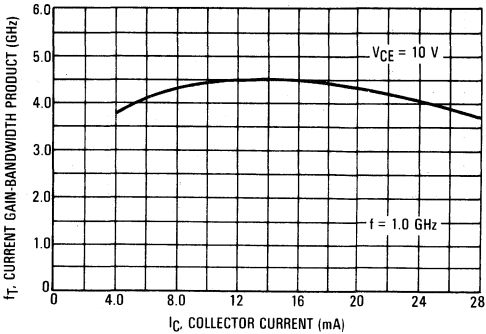


FIGURE 3 — MAXIMUM AVAILABLE GAIN
versus COLLECTOR CURRENT

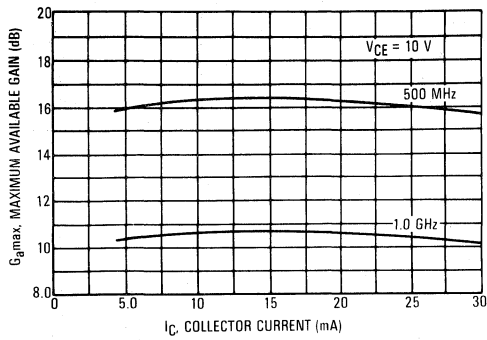


FIGURE 4 — $|S_{21}|^2$ versus FREQUENCY

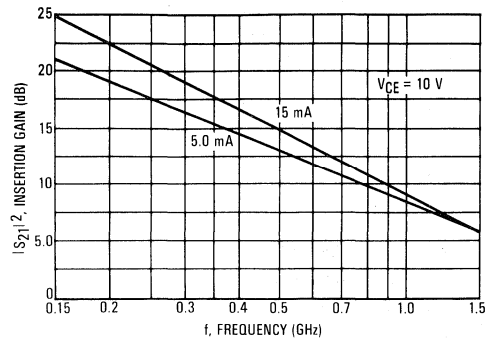


FIGURE 5 — NOISE FIGURE versus
COLLECTOR CURRENT

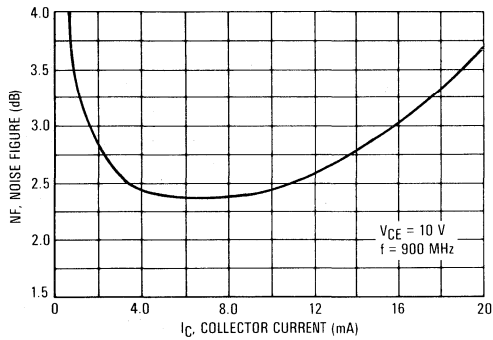


FIGURE 6 — NOISE FIGURE versus FREQUENCY

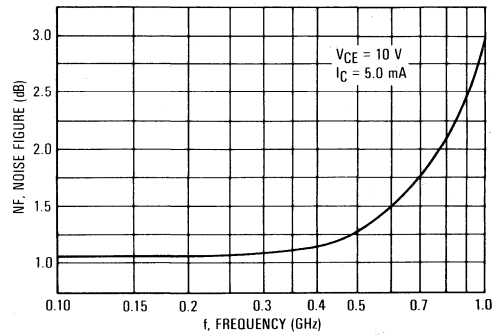


FIGURE 7 — INPUT CAPACITANCE versus
EMITTER-BASE VOLTAGE

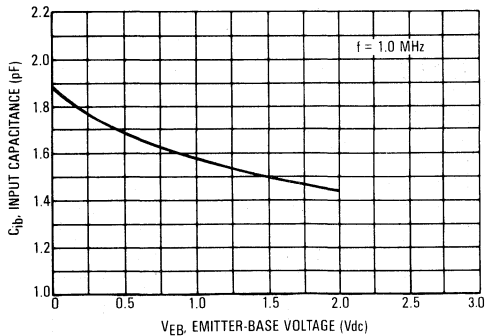


FIGURE 8 — COLLECTOR-BASE CAPACITANCE
versus COLLECTOR-BASE VOLTAGE

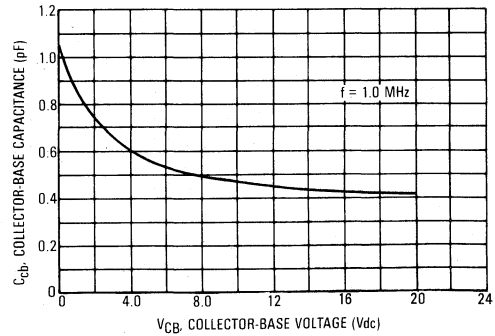


TABLE I

V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
5.0	5.0	100	0.76	-35	9.42	142	0.03	67	0.85	-18
		200	0.60	-63	7.98	122	0.05	58	0.70	-26
		500	0.28	-127	4.79	84	0.09	55	0.53	-35
		1000	0.27	148	2.71	50	0.15	51	0.42	-51
		1500	0.43	113	2.02	23	0.21	42	0.28	-79
	10	100	0.57	-51	14.80	131	0.03	65	0.75	-22
		200	0.36	-87	10.80	108	0.04	62	0.60	-26
		500	0.18	-151	5.23	77	0.08	62	0.48	-31
		1000	0.25	136	2.86	47	0.15	55	0.39	-48
		1500	0.42	109	2.12	22	0.22	42	0.25	-75
	15	100	0.42	-67	17.80	123	0.02	66	0.69	-22
		200	0.26	-105	11.50	101	0.04	66	0.56	-23
		500	0.17	-169	5.27	74	0.08	66	0.47	-28
		1000	0.26	131	2.86	46	0.15	57	0.39	-47
		1500	0.43	108	2.12	21	0.22	44	0.25	-73
	20	100	0.33	-82	18.66	117	0.02	67	0.66	-21
		200	0.22	-120	11.54	98	0.03	68	0.55	-21
		500	0.17	-171	5.16	72	0.08	67	0.48	-27
		1000	0.28	129	2.80	45	0.15	58	0.40	-45
		1500	0.45	107	2.07	19	0.22	45	0.27	-71
	25	100	0.28	-103	18.11	113	0.02	68	0.64	-20
		200	0.22	-138	11.03	95	0.03	70	0.55	-19
		500	0.20	169	4.94	71	0.08	68	0.50	-25
		1000	0.32	128	2.68	43	0.15	60	0.42	-44
		1500	0.49	106	1.98	17	0.22	47	0.30	-71
	30	100	0.31	-127	16.10	109	0.02	67	0.64	-16
		200	0.28	-156	9.69	93	0.03	70	0.57	-16
		500	0.28	160	4.32	69	0.07	70	0.53	-25
		1000	0.39	125	2.37	41	0.14	63	0.46	-44
		1500	0.55	104	1.73	15	0.21	51	0.34	-72

TABLE II

V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
10	5.0	100	0.79	-33	9.36	144	0.03	68	0.88	-15
		200	0.63	-58	7.97	124	0.04	58	0.74	-22
		500	0.28	-117	4.87	86	0.07	57	0.60	-31
		1000	0.23	153	2.80	53	0.13	56	0.50	-46
		1500	0.38	116	2.09	26	0.19	48	0.38	-69
	10	100	0.60	-48	14.87	132	0.02	66	0.79	-18
		200	0.39	-79	11.06	110	0.03	63	0.65	-21
		500	0.16	-135	5.38	79	0.07	64	0.56	-28
		1000	0.20	138	2.97	50	0.13	59	0.47	-44
		1500	0.37	111	2.21	25	0.20	49	0.36	-66
	15	100	0.46	-61	18.20	124	0.02	66	0.74	-18
		200	0.28	-94	11.94	102	0.03	66	0.62	-19
		500	0.14	-154	5.45	76	0.07	67	0.55	-26
		1000	0.22	131	2.97	48	0.13	61	0.48	-42
		1500	0.38	109	2.21	24	0.20	50	0.36	-64
	20	100	0.37	-72	19.38	119	0.02	67	0.71	-17
		200	0.23	-105	11.97	99	0.03	68	0.61	-18
		500	0.14	-172	5.36	74	0.07	69	0.56	-24
		1000	0.23	128	2.91	47	0.13	62	0.48	-41
		1500	0.40	108	2.16	22	0.20	51	0.37	-64
	25	100	0.32	-86	19.40	115	0.02	68	0.70	-16
		200	0.22	-119	11.67	97	0.03	69	0.61	-16
		500	0.19	-176	5.28	74	0.06	70	0.57	-23
		1000	0.26	127	2.82	46	0.13	63	0.50	-41
		1500	0.43	107	2.09	21	0.19	53	0.40	-63
	30	100	0.29	-103	18.29	112	0.02	68	0.70	-14
		200	0.22	-135	10.86	95	0.03	70	0.62	-15
		500	0.20	165	4.82	72	0.06	72	0.59	-22
		1000	0.31	125	2.63	44	0.12	66	0.53	-41
		1500	0.47	106	1.95	19	0.19	55	0.43	-64

The RF Line
NPN Silicon
High Frequency Transistors

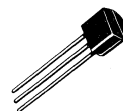
2

... designed for low noise, wide dynamic range front-end amplifiers and low-noise VCO's. Available in a surface-mountable plastic package, as well as the popular TO-226AA (TO-92) package. This Motorola series of small-signal plastic transistors offers superior quality and performance at low cost.

- High Gain-Bandwidth Product
 $f_T = 7 \text{ GHz (Typ) @ 30 mA}$
- Low Noise Figure
 $NF = 1.7 \text{ dB (Typ) @ 500 MHz}$
- High Gain
 $G_{NF} = 17 \text{ dB (Typ) @ 10 mA/500 MHz}$
- State-of-the-Art Technology
 Fine Line Geometry
 Ion-Implanted Arsenic Emitters
 Gold Top Metallization and Wires
 Silicon Nitride Passivation
- Tape and Reel Packaging Options

MPS911
MMBR911

LOW NOISE
HIGH RF GAIN



CASE 29-04, STYLE 2
TO-226AA
(TO-92)
MPS911



CASE 318-05, STYLE 6
SOT-23
MMBR911

MAXIMUM RATINGS

Ratings	Symbol	MPS911	MMBR911	Unit
Collector-Emitter Voltage	V_{CEO}	12		Vdc
Collector-Base Voltage	V_{CBO}	20		Vdc
Emitter-Base Voltage	V_{EBO}	3		Vdc
Collector Current — Continuous	I_C	60		mA
Power Dissipation @ $T_A = 25^\circ\text{C}$	P_D	625	200 (Free Air)	mW
Storage Temperature	T_{stg}	-55 to +150		$^\circ\text{C}$

DEVICE MARKING

MMBR911 = 7P

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	12	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	50	nAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 30\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	30	—	200	—
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DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{cb}	—	—	1	pF
Current Gain-Bandwidth Product ($V_{CE} = 10\text{ Vdc}$, $I_C = 30\text{ mAdc}$, $f = 1\text{ GHz}$) MPS911 MMBR911	f_T	— —	7 6	— —	GHz

FUNCTIONAL TESTS

Gain @ Noise Figure ($I_C = 10\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	MPS911 $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$ MMBR911 $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$	GNF	— — — —	16.5 11 17 11	— — — —	dB
Noise Figure ($I_C = 10\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	MPS911 $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$ MMBR911 $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$	NF	— — — —	1.7 2.7 2 2.9	— — — —	dB

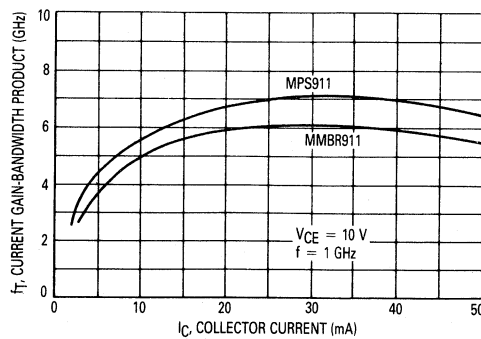


Figure 1. Current Gain-Bandwidth versus Collector Current @ 1 GHz

Figure 2. Input Capacitance versus Base-Emitter Voltage

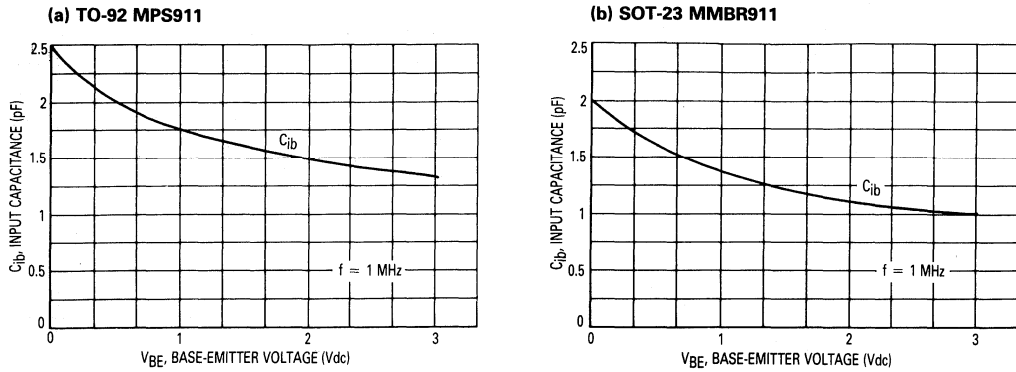


Figure 3. Output Capacitances versus Collector-Base Voltage

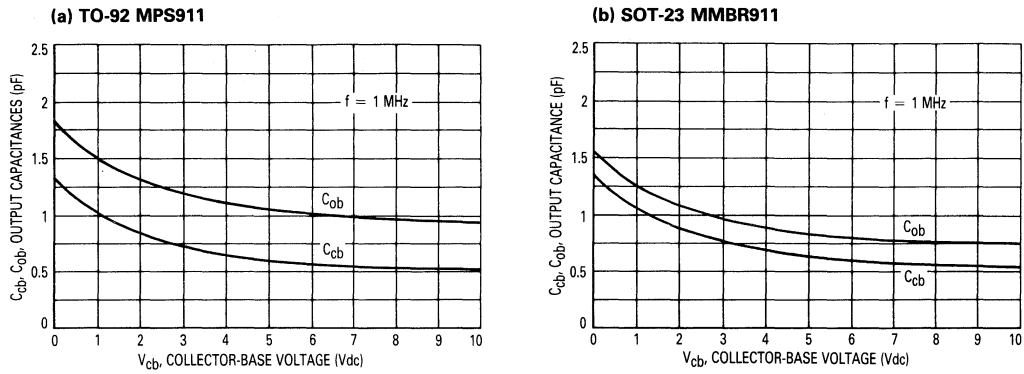


Figure 4. Gain at Noise Figure versus Collector Current

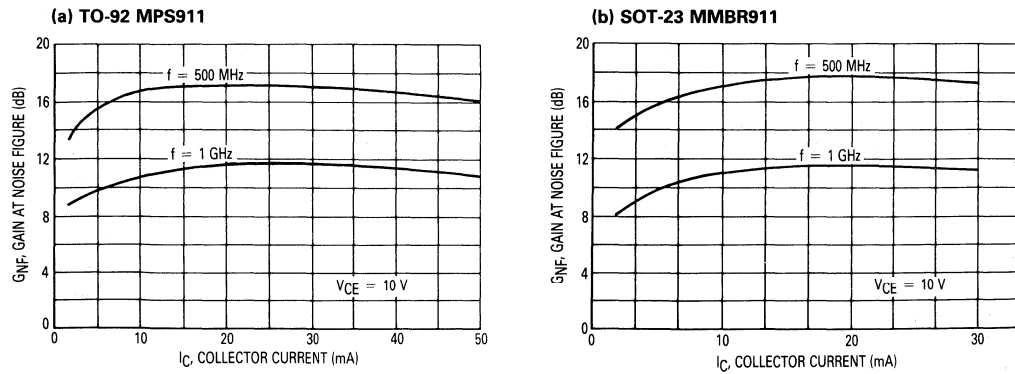


Figure 5. Noise Figure versus Collector Current

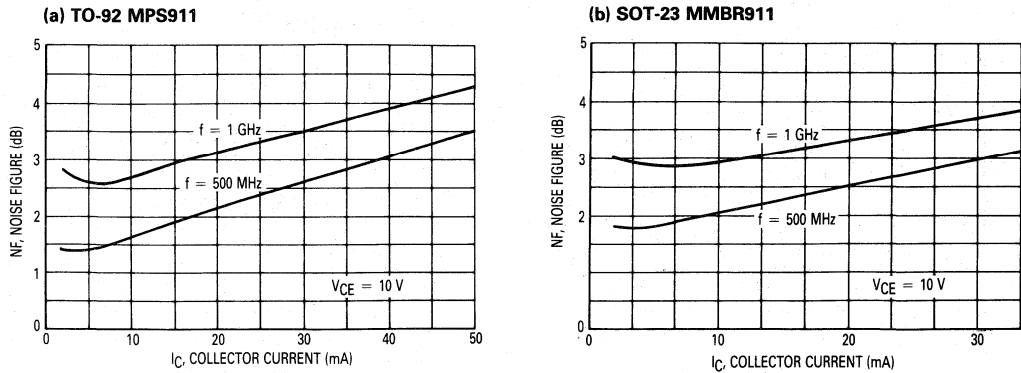


Figure 6. Gain at Noise Figure and Noise Figure versus Frequency

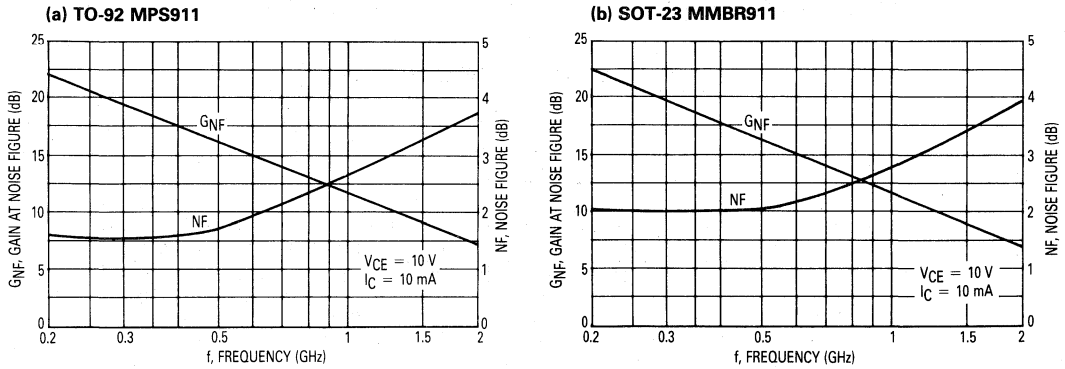
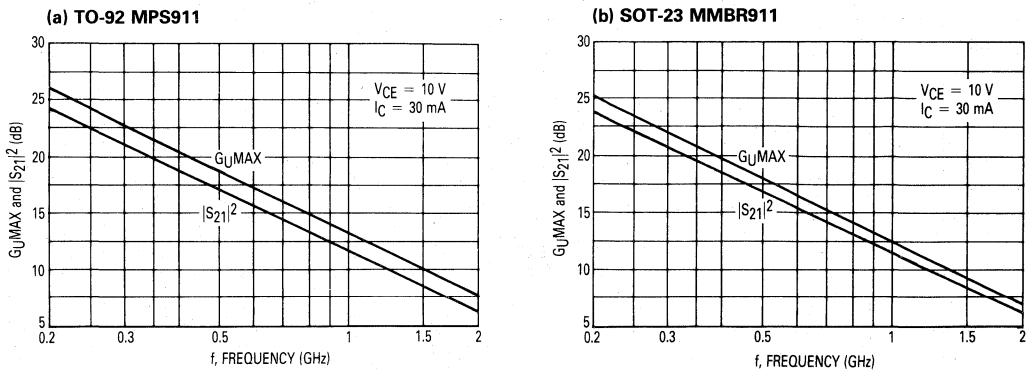
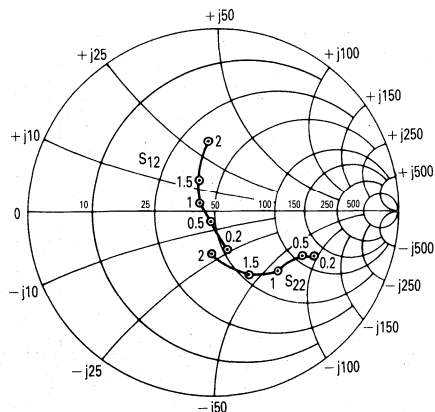


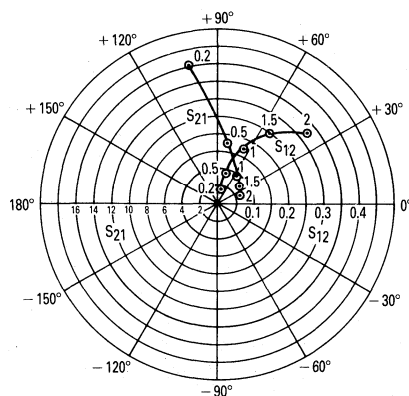
Figure 7. Maximum Unilateral Gain and Insertion Gain versus Frequency



TO-92 MPS911



INPUT AND OUTPUT REFLECTION COEFFICIENTS
versus FREQUENCY
 $V_{CE} = 10 \text{ V}$, $I_C = 30 \text{ mA}$

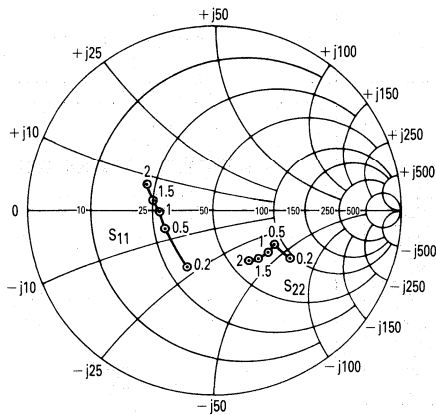


FORWARD AND REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY
 $V_{CE} = 10 \text{ V}$, $I_C = 30 \text{ mA}$

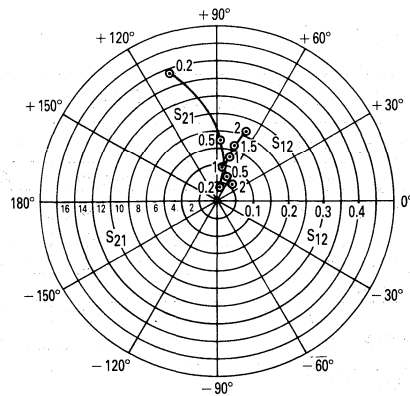
COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle \phi$	$|S_{21}|$	$\angle \phi$	$|S_{12}|$	$\angle \phi$	$|S_{22}|$	$\angle \phi$
10	2	200	0.78	-46	4.42	134	0.06	69	0.95	-18
		500	0.46	-107	3.35	98	0.10	56	0.78	-30
		1000	0.30	172	2.23	61	0.14	54	0.66	-48
		1500	0.41	118	1.66	34	0.20	51	0.57	-70
		2000	0.60	89	1.43	11	0.29	45	0.46	-107
	5	200	0.72	-55	8.75	126	0.05	68	0.87	-23
		500	0.31	-107	5.23	92	0.09	63	0.68	-31
		1000	0.18	178	3.05	61	0.15	60	0.57	-46
		1500	0.27	122	2.22	38	0.22	52	0.50	-66
		2000	0.45	94	1.90	17	0.30	43	0.38	-97
	10	200	0.48	-64	12.79	114	0.04	73	0.74	-24
		500	0.16	-100	6.19	85	0.09	71	0.60	-29
		1000	0.09	165	3.45	59	0.17	63	0.50	-44
		1500	0.22	112	2.50	36	0.25	50	0.41	-65
		2000	0.41	90	2.14	16	0.32	38	0.26	-98
	20	200	0.29	-67	15.30	106	0.04	78	0.65	-23
		500	0.08	-92	6.76	82	0.09	75	0.55	-27
		1000	0.06	144	3.71	58	0.17	64	0.46	-43
		1500	0.20	108	2.65	30	0.25	51	0.37	-63
		2000	0.38	89	2.25	18	0.32	38	0.23	-94
	30	200	0.20	-70	16.04	103	0.04	80	0.61	-22
		500	0.05	-97	6.90	81	0.09	77	0.53	-25
		1000	0.07	138	3.76	58	0.17	66	0.46	-41
		1500	0.20	109	2.68	38	0.25	52	0.37	-61
		2000	0.38	90	2.28	20	0.32	40	0.24	-91
	50	200	0.13	-78	15.26	99	0.04	82	0.62	-18
		500	0.03	-145	6.48	79	0.09	78	0.56	-23
		1000	0.11	126	3.55	56	0.17	67	0.49	-40
		1500	0.24	105	2.56	36	0.25	53	0.39	-62
		2000	0.43	87	2.17	17	0.32	40	0.25	-95

SOT-23 MMBR911



INPUT/OUTPUT REFLECTION COEFFICIENTS
versus FREQUENCY
 $V_{CE} = 10 \text{ V}$, $I_C = 30 \text{ mA}$



FORWARD AND REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY
 $V_{CE} = 10 \text{ V}$, $I_C = 30 \text{ mA}$

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle \phi$	$|S_{21}|$	$\angle \phi$	$|S_{12}|$	$\angle \phi$	$|S_{22}|$	$\angle \phi$
10	2	200	0.82	-45	4.14	145	0.06	66	0.88	-16
		500	0.60	-96	3.23	112	0.09	49	0.71	-27
		1000	0.47	-149	2.16	85	0.11	49	0.62	-34
		1500	0.46	-179	1.59	71	0.13	55	0.58	-43
		2000	0.47	162	1.35	57	0.16	62	0.56	-51
	5	200	0.66	-63	8.63	134	0.05	64	0.75	-25
		500	0.43	-117	5.29	100	0.07	58	0.55	-31
		1000	0.37	-163	3.05	82	0.11	63	0.48	-36
		1500	0.38	176	2.17	70	0.15	65	0.45	-44
		2000	0.40	160	1.81	57	0.19	65	0.43	-51
	10	200	0.49	-83	12.70	124	0.04	65	0.62	-30
		500	0.33	-134	6.42	94	0.07	66	0.44	-32
		1000	0.32	-171	3.53	80	0.12	70	0.41	-36
		1500	0.35	173	2.46	69	0.16	69	0.38	-45
		2000	0.37	159	2.04	58	0.20	66	0.35	-52
	20	200	0.36	-103	15.25	114	0.03	69	0.52	-32
		500	0.28	-149	6.95	90	0.06	72	0.39	-30
		1000	0.29	-176	3.73	78	0.12	73	0.37	-35
		1500	0.33	172	2.60	68	0.17	71	0.34	-43
		2000	0.36	158	2.14	58	0.21	67	0.32	-52
	30	200	0.32	-114	15.64	109	0.03	71	0.48	-29
		500	0.27	-156	6.92	88	0.06	73	0.38	-27
		1000	0.29	-178	3.71	78	0.12	74	0.37	-33
		1500	0.34	170	2.58	68	0.16	72	0.34	-44
		2000	0.37	156	2.13	57	0.21	68	0.32	-51

MPS3866

Die Source Same as 2N3866

The RF Line

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	625 5.0	mW mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	1.5 12	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

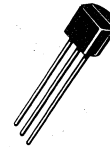
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	$^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 5.0$ mAdc, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	55	—	Vdc
Collector-Emitter Sustaining Voltage ($I_C = 5.0$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	Vdc
Collector Cutoff Current ($V_{CE} = 28$ Vdc, $I_B = 0$)	I_{CEO}	—	0.02	mAdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE} = -1.5$ Vdc (Rev.), $T_C = 150^\circ\text{C}$) ($V_{CE} = 55$ Vdc, $V_{BE} = -1.5$ Vdc (Rev.))	I_{CEX}	— —	5.0 0.1	mAdc
Emitter Cutoff Current ($V_{BE} = 3.5$ Vdc, $I_C = 0$)	I_{EBO}	—	0.1	mAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 360$ mAdc, $V_{CE} = 5.0$ Vdc)(1) ($I_C = 50$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	5.0 10	— 200	—
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 20$ mAdc)	$V_{CE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 15$ Vdc, $f = 200$ MHz)	f_T	500	—	MHz
Output Capacitance ($V_{CB} = 28$ Vdc, $I_E = 0$, $f = 1.0$ MHz)	C_{obo}	—	3.0	pF
FUNCTIONAL TEST				
Amplifier Power Gain ($V_{CC} = 28$ Vdc, $P_{out} = 1.0$ W, $f = 400$ MHz)	G_{pe}	10	—	dB
Collector Efficiency ($V_{CC} = 28$ Vdc, $P_{out} = 1.0$ W, $f = 400$ MHz)	η	45	—	%

(1) Pulse Test: Pulse Width $\leq 300\ \mu\text{s}$, Duty Cycle $\leq 2.0\%$.

AMPLIFIER TRANSISTOR
NPN SILICON



CASE 29-04
TO-226AA
(TO-92)

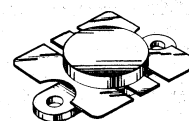
The RF Line UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 225 to 400 MHz frequency range.

- Designed for Class AB Linear Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
Output Power — 30 Watts
Power Gain — 9 dB Min
- Built-In Matching Network for Broadband Operation Using Double Matching Technique
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MRA0204-30V

9 dB
225-400 MHz
30 WATTS
BROADBAND
UHF POWER
TRANSISTOR



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	6	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25$ mA, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ V, $I_E = 0$)	I_{CBO}	—	—	15	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	40	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 30\text{ W}$, $f = 400\text{ MHz}$, $I_{CQ} = 60\text{ mA}$)	G_{PE}	9	10.5	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $I_{CQ} = 60\text{ mA}$, $P_{out} = 30\text{ W}$, $f = 400\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($f = 400\text{ MHz}$, $V_{CE} = 28\text{ V}$, $I_{CQ} = 60\text{ mA}$)	P_{sat}	40	—	—	W

TYPICAL CHARACTERISTICS

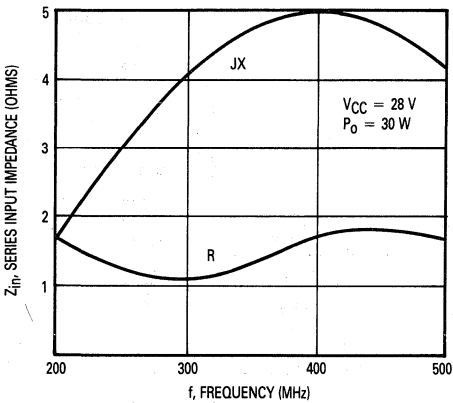


Figure 1. Input Impedance versus Frequency

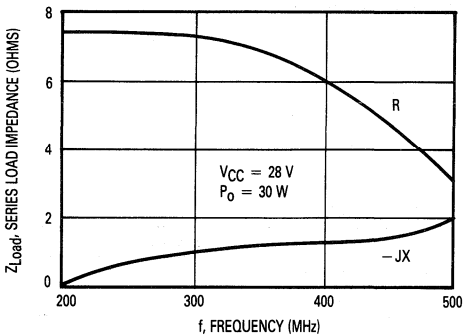


Figure 2. Load Impedance versus Frequency

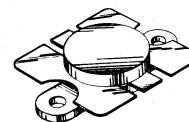
MRA0204-60

The RF Line UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 225 to 400 MHz frequency range.

- Designed for Class C or Class AB Linear Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
 - Output Power — 60 Watts
 - Power Gain — 8.2 dB Min, Class C
 - 9.5 dB Min, Class AB
- Built-In Matching Network for Broadband Operation Using Double Matching Technique
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

8 dB
225-400 MHz
60 WATTS
BROADBAND
UHF POWER
TRANSISTOR



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25$ mA, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ V, $I_E = 0$)	I_{CBO}	—	—	20	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	72	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain — Class C ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$)	G_{PE1}	8.2	—	—	dB
Common-Emitter Amplifier Power Gain — Class AB ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$, $I_{CQ} = 120\text{ mA}$)	G_{PE2}	9.5	—	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$, Load VSWR = 5:1, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28\text{ V}$, $f = 400\text{ MHz}$)	P_{sat}	70	—	—	W

2

TYPICAL CHARACTERISTICS

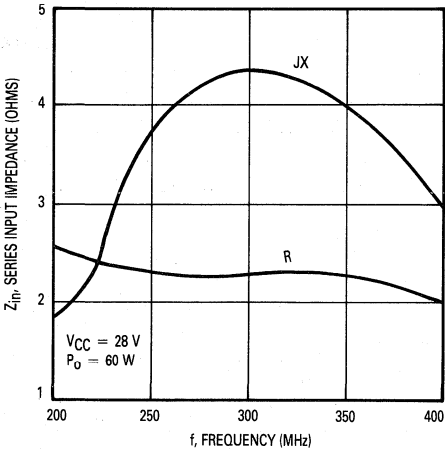


Figure 1. Input Impedance versus Frequency

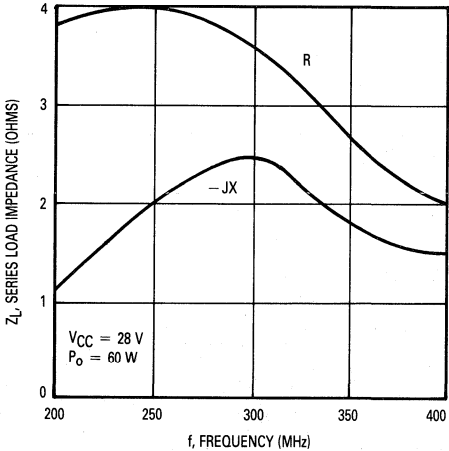


Figure 2. Load Impedance versus Frequency

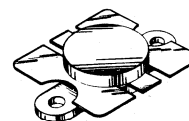
MRA0204-60V

The RF Line UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 225 to 400 MHz frequency range.

- Designed for Class C or Class AB Linear Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
 - Output Power — 60 Watts
 - Power Gain — 7.8 dB Min, Class C
 - 8.5 dB Min, Class AB
- Built-In Matching Network for Broadband Operation Using Double Matching Technique
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

8 dB
225-400 MHz
60 WATTS
BROADBAND
UHF POWER
TRANSISTOR



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25$ mA, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ V, $I_E = 0$)	I_{CBO}	—	—	20	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	80	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain — Class C ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$)	G_{PE1}	7.8	—	—	dB
Common-Emitter Amplifier Power Gain — Class AB ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$, $I_{CQ} = 120\text{ mA}$)	G_{PE2}	8.5	—	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28\text{ V}$, $f = 400\text{ MHz}$)	P_{sat}	70	—	—	W

Figure 1. Input Impedance versus Frequency

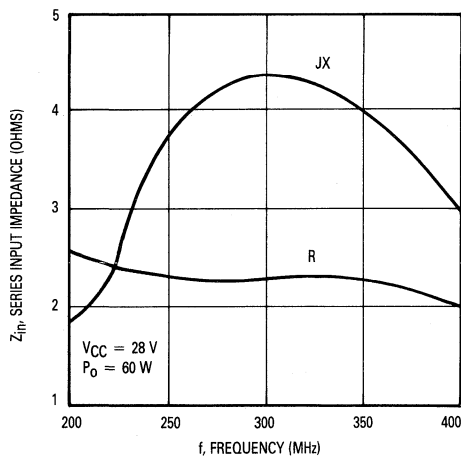
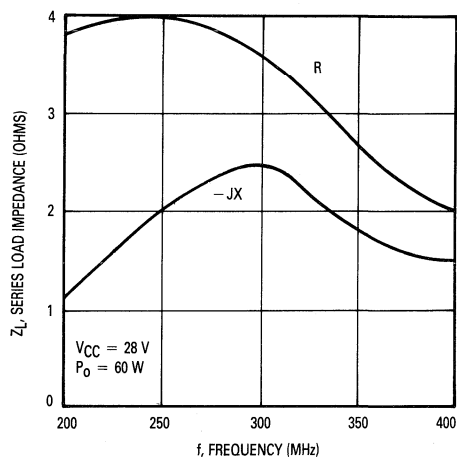


Figure 2. Load Impedance versus Frequency



MRA0204-60VH

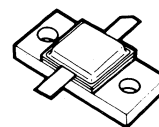
The RF Line

UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.2 to 1.4 GHz frequency range.

- Designed for Class C or Class AB Linear Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
 - Output Power — 60 Watts
 - Power Gain — 7.8 dB Min, Class C
 - 8 dB Min, Class AB
- Built-In Matching Networks — Input and Output — for Broadband
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

8 dB
225–400 MHz
60 WATTS
BROADBAND
UHF POWER
TRANSISTOR



HLP-19
CASE 402A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	– 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25 \text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30 \text{ V}$, $I_E = 0$)	I_{CBO}	—	—	20	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1 \text{ A}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	—	80	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain — Class C ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$)	GPE1	7.8	—	—	dB
Common-Emitter Amplifier Power Gain — Class AB ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$, $I_{CQ} = 120\text{ mA}$)	GPE2	8	9	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

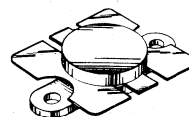
The RF Line UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 225 to 400 MHz frequency range.

- Designed for Class AB Linear Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
Output Power — 70 Watts
Power Gain — 8.5 dB Min, Class AB
- Built-In Matching Network for Broadband Operation Using Double Matching Technique
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MRA0204-70

**8.5 dB
225–400 MHz
70 WATTS
BROADBAND
UHF POWER
TRANSISTOR**



**.500 J ZERO
CASE 316A-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	12	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	– 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.2	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 35$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 35$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 35$ mA, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ V, $I_E = 0$)	I_{CBO}	—	—	30	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	80	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 70\text{ W}$, $f = 400\text{ MHz}$, $I_{CQ} = 120\text{ mA}$)	G_{PE}	8.5	9.5	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 70\text{ W}$, $f = 400\text{ MHz}$, Load VSWR = 5:1, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28\text{ V}$, $I_{CQ} = 120\text{ mA}$, $f = 400\text{ MHz}$)	P_{sat}	80	—	—	W

TYPICAL CHARACTERISTICS

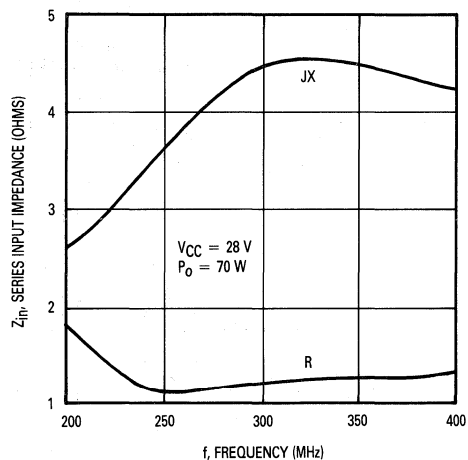


Figure 1. Input Impedance versus Frequency

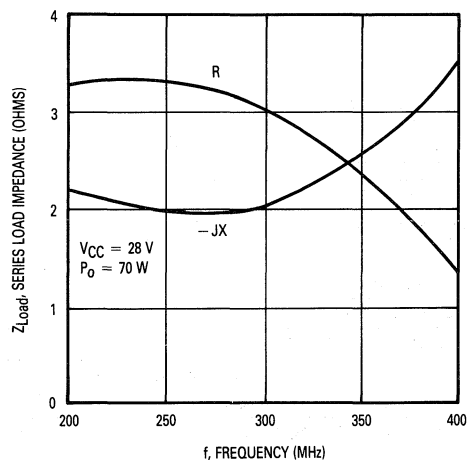


Figure 2. Load Impedance versus Frequency

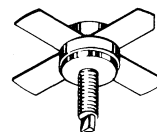
MRA0500-19L

The RF Line
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages to 500 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 500 MHz Characteristics:
 - Output Power — 19 Watts, 1 dB Compression
 - Power Gain — 8 dB Min, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**8 dB
 TO 500 MHz
 19 WATTS
 BROADBAND
 UHF POWER
 TRANSISTOR**



**.380 SOE
 CASE 145D-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	117 0.667	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	1.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 19\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	30	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	90	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 24\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	75	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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FUNCTIONAL TESTS

Common-Emitter Amplifier Small-Signal Gain ($V_{CE} = 19\text{ V}$, $P_{in} = 1\text{ mW}$, $f = 500\text{ MHz}$)	G_{SS}	8	—	—	dB
Load Mismatch ($V_{CE} = 19\text{ V}$, $I_C = 3.5\text{ A}$, $P_{out} = 19\text{ W}$, $f = 500\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive ($V_{CE} = 19\text{ V}$, $I_C = 3.5\text{ A}$, $f = 500\text{ MHz}$) (No degradation)	P_{inover}	—	—	10	W
Output Power, 1 dB Compression Point ($V_{CE} = 19\text{ V}$, $f = 500\text{ MHz}$, $I_C = 3.5\text{ A}$)	$P_{o1\text{ dB}}$	19	—	—	W

The RF Line

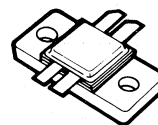
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 500 to 1000 MHz frequency range.

- Designed for Class AB Linear Power Amplifiers
- Specified 28 Volt, 1000 MHz Characteristics:
 - Output Power — 50 Watts
 - Power Gain — 7 dB Min, Class AB
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

MRA0510-50H

7 dB
500–1000 MHz
50 WATTS
BROADBAND
UHF POWER
TRANSISTOR



HLP-42
CASE 391-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	125 0.715	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	- 65 to + 200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	1.4	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (Note 1)

Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $R_{BE} = 1\ \Omega$)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	25	mAdc

ON CHARACTERISTICS (Note 1)

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	80	—
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DYNAMIC CHARACTERISTICS (Note 1)

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	24	pF
--	----------	---	---	----	----

Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 50\text{ W}$, $f = 1\text{ GHz}$, $I_{CQ} = 2 \times 120\text{ mA}$)	GPE	7	—	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $I_{CQ} = 2 \times 120\text{ mA}$, $P_{out} = 50\text{ W}$, $f = 1\text{ GHz}$, Load VSWR = 5:1, All Phase Angles)	ψ	No Degradation in Output Power			

Note 2. Both transistor chips operating in push-pull amplifier.

TYPICAL CHARACTERISTICS

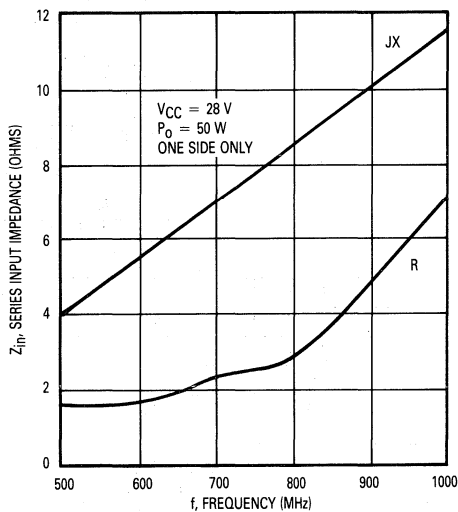


Figure 1. Input Impedance versus Frequency

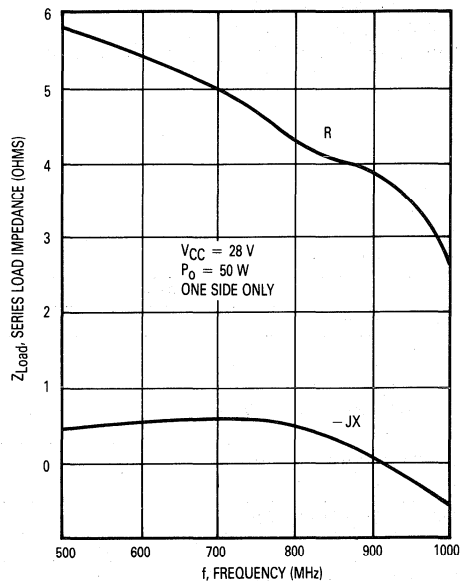


Figure 2. Load Impedance versus Frequency

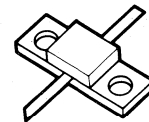
The RF Line UHF Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 600 to 1000 MHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1000 MHz Characteristics:
 - Output Power — 3 to 40 Watts
 - Power Gain — 7 to 7.8 dB Min, Common Base
 - Collector Efficiency — 50 to 55%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MRA0610 Series

7 to 7.8 dB
600–1000 MHz
3 TO 40 WATTS
BROADBAND
UHF POWER
TRANSISTORS



MRA .25
CASE 394-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-3	-9	-18A	-40A	Unit
Collector-Base Voltage	V_{CES}	50				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1.5	2.5	5	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	-65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	6	4	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $V_{BE} = 0$) ($I_C = 60$ mA, $V_{BE} = 0$) ($I_C = 100$ mA, $V_{BE} = 0$) ($I_C = 200$ mA, $V_{BE} = 0$)	MRA0610-3 -9 -18A -40A	$V_{(BR)CES}$	50 50 50 50	— — — —	— — — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.25$ mA, $I_C = 0$) ($I_E = 0.75$ mA, $I_C = 0$) ($I_E = 1.25$ mA, $I_C = 0$) ($I_E = 2.5$ mA, $I_C = 0$)	MRA0610-3 -9 -18A -40A	$V_{(BR)EBO}$	3.5 3.5 3.5 3.5	— — — —	— — — —	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	MRA0610-3 -9 -18A -40A	I_{CBO1}	— — — —	— — — —	0.5 1.5 2.5 5	mAdc

(continued)

MRA0610 Series

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain ($I_C = 0.1 \text{ A}$, $V_{CE} = 5 \text{ V}$) ($I_C = 0.3 \text{ A}$, $V_{CE} = 5 \text{ V}$) ($I_C = 0.5 \text{ A}$, $V_{CE} = 5 \text{ V}$) ($I_C = 1 \text{ A}$, $V_{CE} = 5 \text{ V}$)	MRA0610-3 -9 -18A -40A	10 10 10 10	— — — —	100 100 100 100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	MRA0610-3 -9 -18A -40A	— — — —	— — — —	4.5 10 14 28	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CE} = 28 \text{ V}$, $P_{out} = 3 \text{ W}$, $f = 1 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 9 \text{ W}$, $f = 1 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 18 \text{ W}$, $f = 1 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 40 \text{ W}$, $f = 1 \text{ GHz}$)	MRAL0610-3 -9 -18A -40A	7.8 7.8 7.8 7	— — — —	— — — —	dB
Collector Efficiency ($V_{CE} = 28 \text{ V}$, $P_{out} = 3 \text{ W}$, $f = 1 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 9 \text{ W}$, $f = 1 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 18 \text{ W}$, $f = 1 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 40 \text{ W}$, $f = 1 \text{ GHz}$)	MRA0610-3 -9 -18A -40A	50 55 50 50	— — — —	— — — —	%

TYPICAL CHARACTERISTICS

MRA0610-3 — 3 WATTS BROADBAND

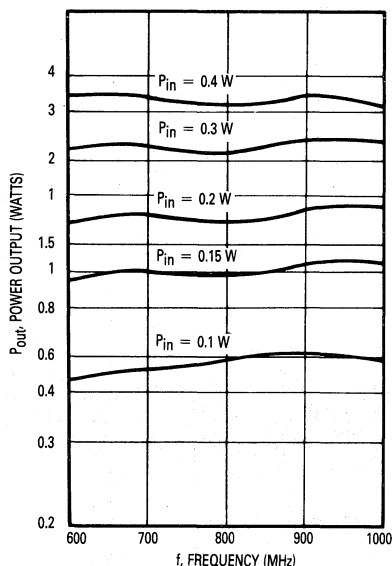


Figure 1. Power Output versus Frequency

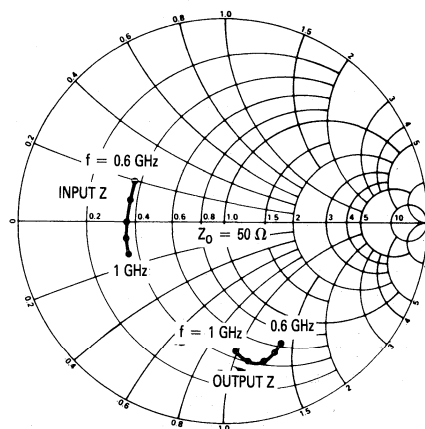


Figure 2. Series Equivalent Input/Output Impedance
 $V_{CC} = 28 \text{ V}$

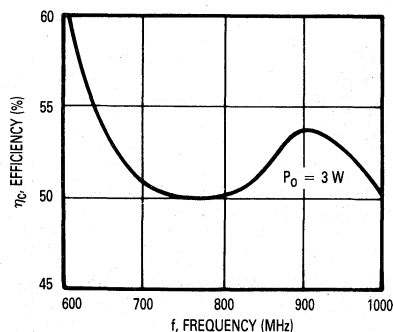


Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA0610-9 — 9 WATTS BROADBAND

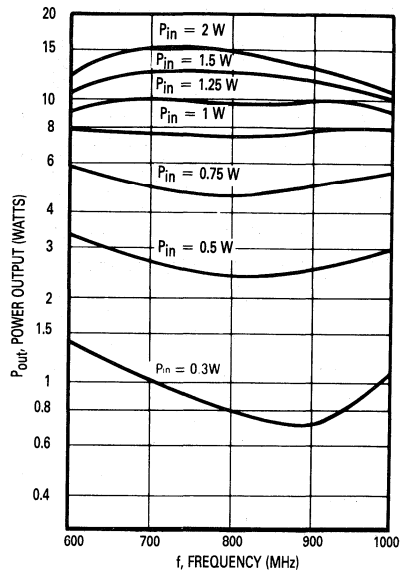


Figure 4. Power Output versus Frequency

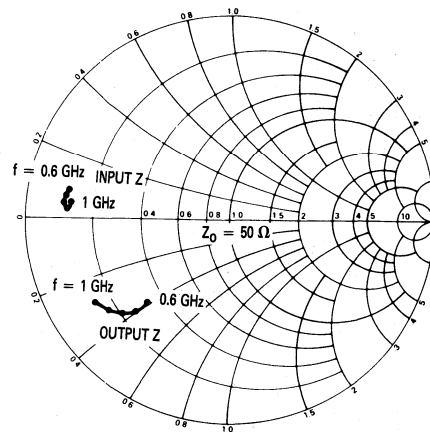
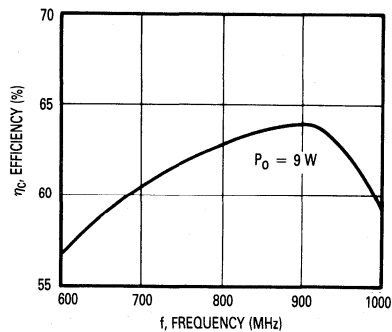
Figure 5. Series Equivalent Input/Output Impedance
 $V_{CC} = 28 \text{ V}$ 

Figure 6. Efficiency versus Frequency

TYPICAL CHARACTERISTICS
MRA0610-18A — 18 WATTS BROADBAND

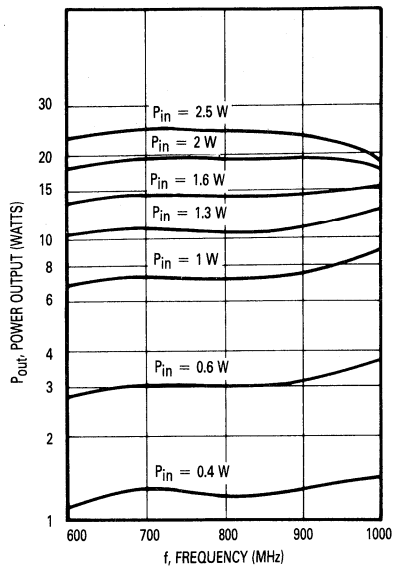


Figure 7. Power Output versus Frequency

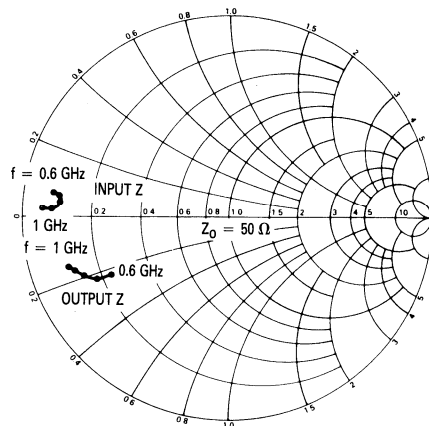


Figure 8. Series Equivalent Input/Output Impedance
 $V_{CC} = 28 \text{ V}$

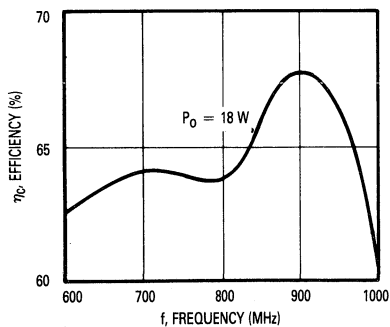


Figure 9. Efficiency versus Frequency

TYPICAL CHARACTERISTICS
MRA0610-40A — 40 WATTS BROADBAND

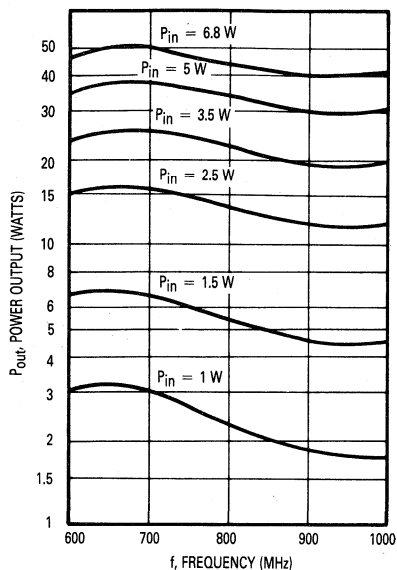


Figure 10. Power Output versus Frequency

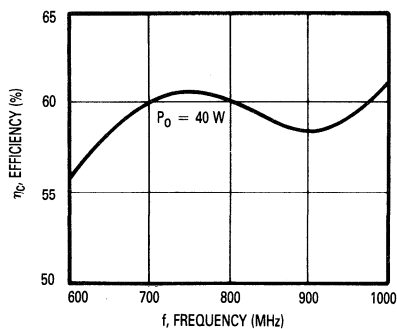


Figure 12. Efficiency versus Frequency

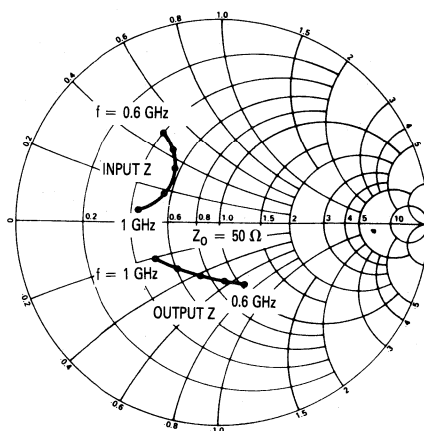


Figure 11. Series Equivalent Input/Output Impedance
 $V_{CC} = 28 \text{ V}$

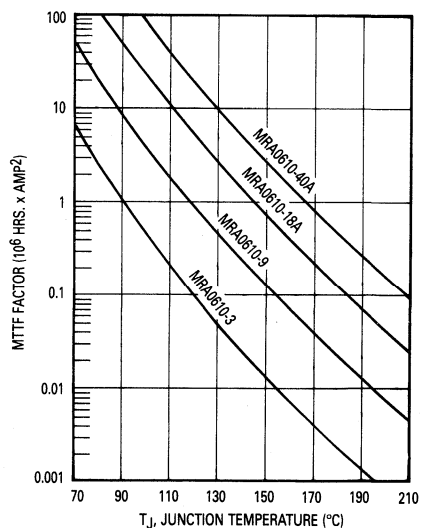
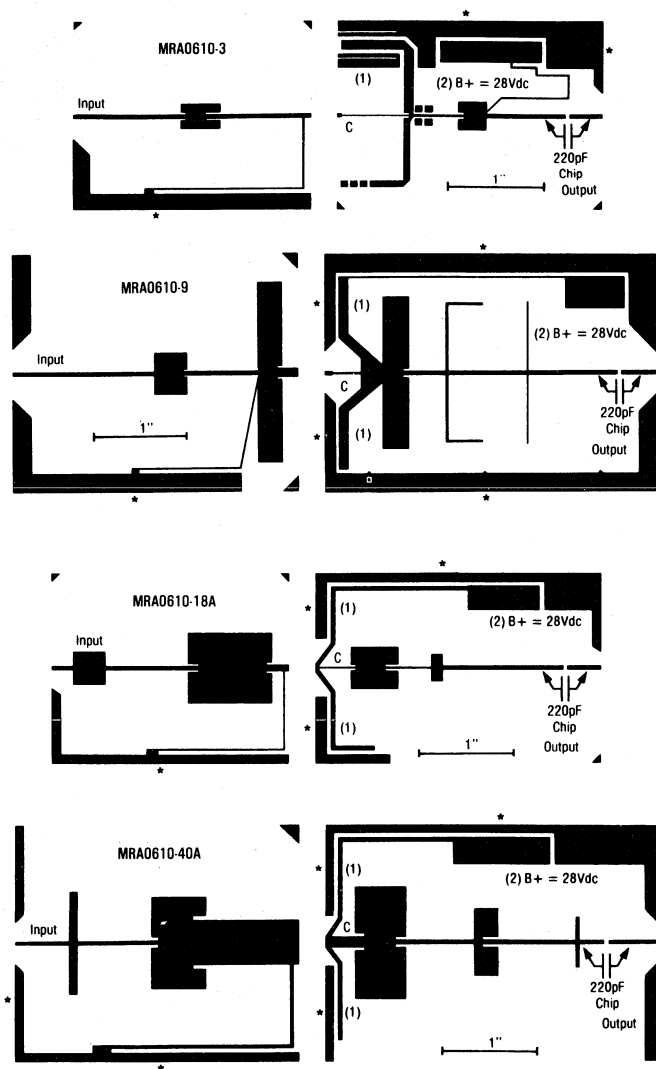


Figure 13. MTTF Factor versus Junction Temperature

Note: Divide by I_C^2 to obtain metal lifetime in hours



*Foil wrap or plate around to ground plane. Board material 0.020 inch glass-epoxy $\epsilon_r = 2.55$.

(1) Bypass capacitor to ground for shunt inductor (220pF chip).

(2) Use B+ bypass of 0.01 and 1 μ F capacitors at this point.

Figure 14. Test Circuit Boards for MRA0610 Series

(Not to Scale)

The RF Line

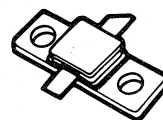
UHF Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 600 to 1000 MHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1000 MHz Characteristics:
 - Output Power — 3 to 18 Watts
 - Power Gain — 7.8 dB Min, Common Base
 - Collector Efficiency — 50 to 55%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

MRA0610H Series

7.8 dB
600–1000 MHz
3 TO 18 WATTS
BROADBAND
UHF POWER
TRANSISTORS



HLP-11
 CASE 393-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-3H	-9H	-18H	Unit
Collector-Base Voltage	V_{CES}		50		Vdc
Emitter-Base Voltage	V_{EBO}		3.5		Vdc
Collector Current — Continuous	I_C	0.5	1.5	2.5	Adc
Operating Junction Temperature	T_J		200		°C
Storage Temperature Range	T_{stg}		-65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	6	4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $V_{BE} = 0$) ($I_C = 60$ mA, $V_{BE} = 0$) ($I_C = 100$ mA, $V_{BE} = 0$)	MRA0610- 3H - 9H -18H	$V_{(BR)CES}$	50 50 50	— — —	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.25$ mA, $I_C = 0$) ($I_E = 0.75$ mA, $I_C = 0$) ($I_E = 1.25$ mA, $I_C = 0$)	MRA0610- 3H - 9H -18H	$V_{(BR)EBO}$	3.5 3.5 3.5	— — —	— — —	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	MRA0610- 3H - 9H -18H	I_{CBO}	— — —	— — —	0.5 1.5 2.5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mA, $V_{CE} = 5$ V) ($I_C = 300$ mA, $V_{CE} = 5$ V) ($I_C = 500$ mA, $V_{CE} = 5$ V)	MRA0610- 3H - 9H -18H	h_{FE}	10 10 10	— — —	100 100 100	—
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CE} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	MRA0610- 3H - 9H -18H	C_{ob}	— — —	— — —	4.5 10 14	pF
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FUNCTIONAL TESTS

Common-Base Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 3\text{ W}$, $f = 1\text{ GHz}$) ($V_{CE} = 28\text{ V}$, $P_{out} = 9\text{ W}$, $f = 1\text{ GHz}$) ($V_{CE} = 28\text{ V}$, $P_{out} = 18\text{ W}$, $f = 1\text{ GHz}$)	MRA0610- 3H - 9H -18H	G_{PB}	7.8 7.8 7.8	— — —	— — —	dB
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 3\text{ W}$, $f = 1\text{ GHz}$) ($V_{CE} = 28\text{ V}$, $P_{out} = 9\text{ W}$, $f = 1\text{ GHz}$) ($V_{CE} = 28\text{ V}$, $P_{out} = 18\text{ W}$, $f = 1\text{ GHz}$)	MRA0610- 3H - 9H -18H	η_c	50 55 55	— — —	— — —	%

TYPICAL CHARACTERISTICS

Note: Divide by I_{C2} to obtain metal lifetime in hours.

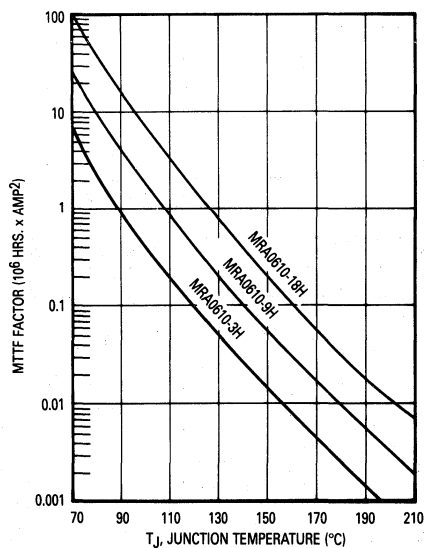


Figure 1. MTTF Factor versus Junction Temperature

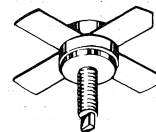
MRA1000-3.5L

The RF Line
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages to 1000 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 1000 MHz Characteristics:
Output Power — 3.5 Watts
Power Gain — 10 dB, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**10 dB
TO 1000 MHz
3.5 WATTS
BROADBAND
UHF POWER
TRANSISTOR**



**.380 SOE
CASE 145D-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	22 0.125	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	8	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 250\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	90	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 24\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	15	pF
--	----------	---	---	----	----

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain ($V_{CE} = 19\text{ V}$, $P_{in} = 1\text{ mW}$, $f = 1\text{ GHz}$, $I_C = 600\text{ mA}$)	G_{SS}	10	—	—	dB
Load Mismatch ($V_{CE} = 19\text{ V}$, $I_C = 600\text{ mA}$, $P_{out} = 3.5\text{ W}$, $f = 1\text{ GHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive ($V_{CE} = 19\text{ V}$, $I_C = 600\text{ mA}$, $f = 1\text{ GHz}$) (No degradation)	P_{inover}	—	—	1.75	W

TYPICAL CHARACTERISTICS

Freq. (MHz)	S11		S12		S21		S22	
	dB	Ang	dB	Ang	dB	Ang	dB	Ang
500	-0.82<	174.2	-30.81<	22.6	5.01<	53.2	-5.14<	-164.3
600	-0.95<	172.7	-30.44<	21.4	4.32<	46.8	-4.68<	-170.0
700	-1.16<	170.5	-30.33<	18.6	3.72<	36.2	-3.99<	-158.6
800	-1.42<	168.2	-29.89<	14.7	3.58<	23.7	-3.37<	-157.3
900	-1.72<	167.7	-30.27<	5.2	3.49<	10.2	-2.60<	-157.5
1000	-2.20<	168.3	-31.86<	-3.6	3.53<	-7.4	-1.58<	-160.0

Figure 1. Common Emitter S-Parameters

Freq. (MHz)	Z_{OUT} (Ohms)		Z_{IN} (Ohms)	
	Re	Im	Re	Im
500	14.6	-6.31	2.36	2.53
600	13.2	-4.07	2.74	3.18
700	11.7	-8.95	3.36	4.14
800	9.95	-8.65	4.12	5.13
900	7.72	-9.72	4.99	5.33
1000	4.67	-8.74	6.36	5.04

Figure 2. Z_{IN} and Z_{OUT} versus Frequency

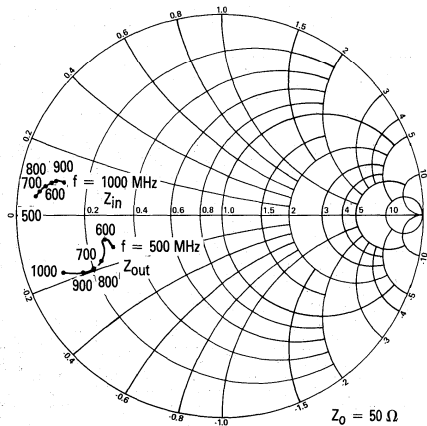


Figure 3. Series Equivalent Input/Output Impedance

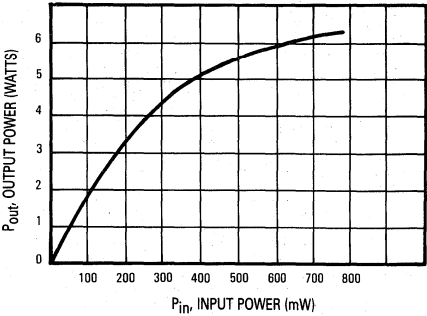
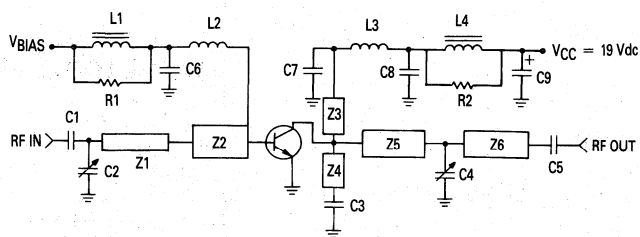


Figure 4. Power Input versus Power Output



L1 — 7T, 20 Gauge on 200 Mil Ferrite Toroid
 L2 — 8T, 20 Gauge, 100 Mil Dia.
 L3 — 11T, 20 Gauge, 100 Mil Dia.
 L4 — 8T, 20 Gauge, on 275 Mil Ferrite Toroid
 C1, C3, C5, C6, C7 — 500 pF ATC
 C2, C4 — 0.8–10 pF JFD
 C9 — 0.1 μ F, 50 V, Ceramic
 R1, R2 — 15 Ω , 1/4 Watt

Z1 — 50 Ω , microstripline, $\ell = 0.110\lambda$
 Z2 — 10 Ω , microstripline, $\ell = 0.162\lambda$
 Z3, Z4 — 50 Ω , microstripline, $\ell = 0.052\lambda$
 Z5 — 24 Ω , microstripline, $\ell = 0.080\lambda$
 Z6 — 50 Ω , microstripline, $\ell = 0.125\lambda$

Figure 5. 1 GHz Test Circuit

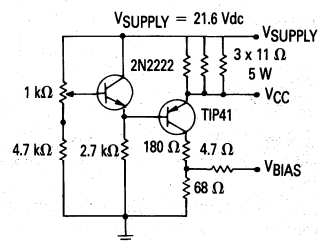
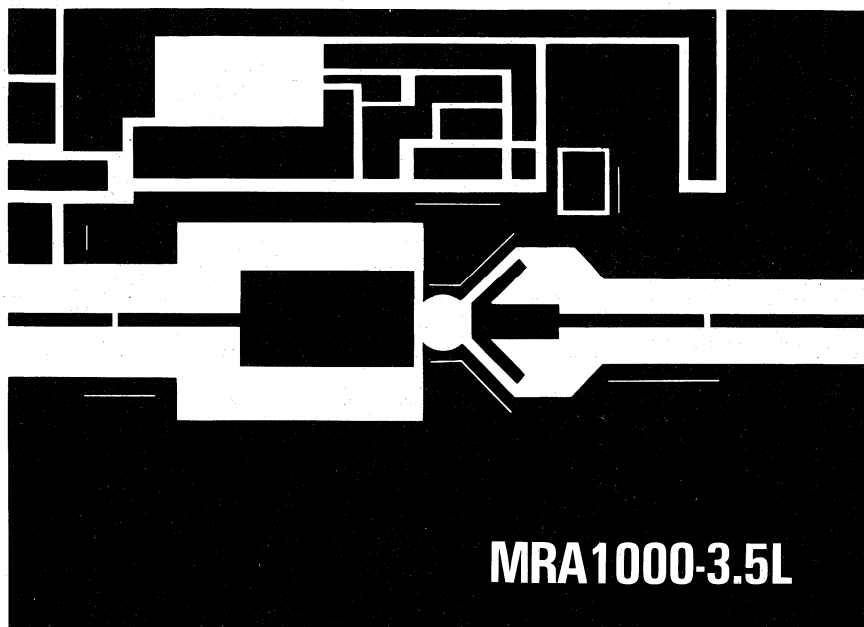


Figure 6. Bias Circuit

Test Circuit Mask



(Not to Scale)
 Board Material = 1/32 Teflon-Fiberglass

Figure 7. Test Circuit Mask

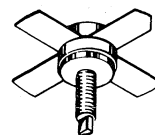
The RF Line **UHF Power Transistor**

... designed primarily for wideband, large-signal output and driver amplifier stages to 1000 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 1000 MHz Characteristics:
 - Output Power — 7 Watts
 - Power Gain — 9 dB Min, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MRA1000-7L

**9 dB
 TO 1000 MHz
 7 WATTS
 BROADBAND
 UHF POWER
 TRANSISTOR**



**.380 SOE
 CASE 145D-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	28	V _{dc}
Collector-Base Voltage	V _{CBO}	50	V _{dc}
Emitter-Base Voltage	V _{EBO}	3.5	V _{dc}
Total Device Dissipation @ T _C = 25°C Derate above 25°C	P _D	42 0.25	Watts W/°C
Operating Junction Temperature	T _J	200	°C
Storage Temperature Range	T _{stg}	- 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T _C = 70°C)	R _{θJC}	4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (I _C = 20 mA, I _B = 0)	V _{(BR)CEO}	28	—	—	V _{dc}
Collector-Emitter Breakdown Voltage (I _C = 20 mA, V _{BE} = 0)	V _{(BR)CES}	50	—	—	V _{dc}
Collector-Base Breakdown Voltage (I _C = 20 mA, I _E = 0)	V _{(BR)CBO}	50	—	—	V _{dc}
Emitter-Base Breakdown Voltage (I _E = 5 mA, I _C = 0)	V _{(BR)EBO}	3.5	—	—	V _{dc}
Collector Cutoff Current (V _{CB} = 19 V, I _E = 0)	I _{CBO}	—	—	15	mA _{dc}

ON CHARACTERISTICS

DC Current Gain (I _C = 1 A, V _{CE} = 5 V)	h _{FE}	20	—	90	—
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DYNAMIC CHARACTERISTICS

Output Capacitance (V _{CB} = 24 V, I _E = 0, f = 1 MHz)	C _{ob}	—	—	22	pF
--	-----------------	---	---	----	----

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain ($V_{CE} = 19\text{ V}$, $f = 1\text{ GHz}$, $I_C = 1.2\text{ A}$)	G_{SS}	9	10	—	dB
Load Mismatch ($V_{CE} = 19\text{ V}$, $I_C = 1.2\text{ A}$, $P_{out} = 7\text{ W}$, $f = 1\text{ GHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive ($V_{CE} = 19\text{ V}$, $I_C = 1.2\text{ A}$, $f = 1\text{ GHz}$) (No degradation)	P_{inover}	—	—	3.5	W
Output Power, 1 dB Compression Point ($V_{CE} = 19\text{ V}$, $f = 1\text{ GHz}$, $I_C = 1.2\text{ A}$)	$P_{o1\text{ dB}}$	7	—	—	W

2

TYPICAL CHARACTERISTICS

Freq. (GHz)	S11		S12		S21		S22	
	dB	Ang	dB	Ang	dB	Ang	dB	Ang
500	-0.45<	174.2	-32.52<	47.8	0.64<	56.0	-3.05<	-178.8
600	-0.55<	173.1	-31.39<	47.2	0.09<	48.4	-3.05<	-177.3
700	-0.71<	171.1	-30.71<	44.6	-0.29<	38.4	-2.94<	-175.9
800	-0.92<	169.4	-29.78<	39.8	-0.26<	25.6	-2.80<	-174.8
900	-1.17<	168.1	-30.13<	32.0	-0.13<	11.3	-2.44<	-173.6
1000	-1.59<	168.1	-31.39<	29.9	-0.09<	-9.2	-1.72<	-173.9

Figure 1. Common Emitter S-Parameters

Freq. (MHz)	ZOUT (Ohms)		ZIN (Ohms)	
	Re	Im	Re	Im
500	8.69	-0.51	1.30	2.53
600	8.69	-1.14	1.59	3.01
700	8.39	-1.74	2.05	3.88
800	8.01	-2.21	2.67	4.63
900	7.00	-2.74	3.40	5.19
1000	4.95	-2.64	4.61	5.17

Figure 2. ZIN and ZOUT versus Frequency

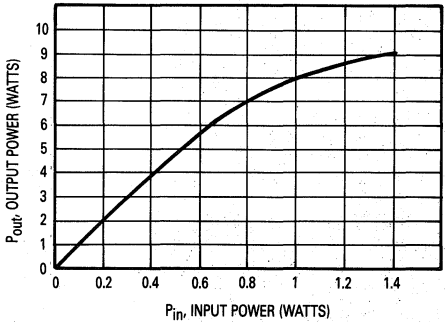


Figure 3. Power Output versus Power Input

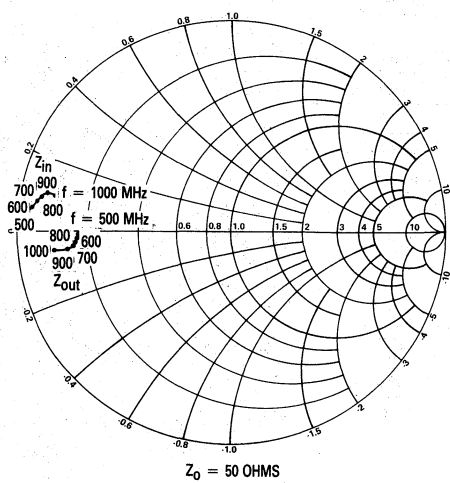


Figure 4. Series Equivalent Input/Output Impedance

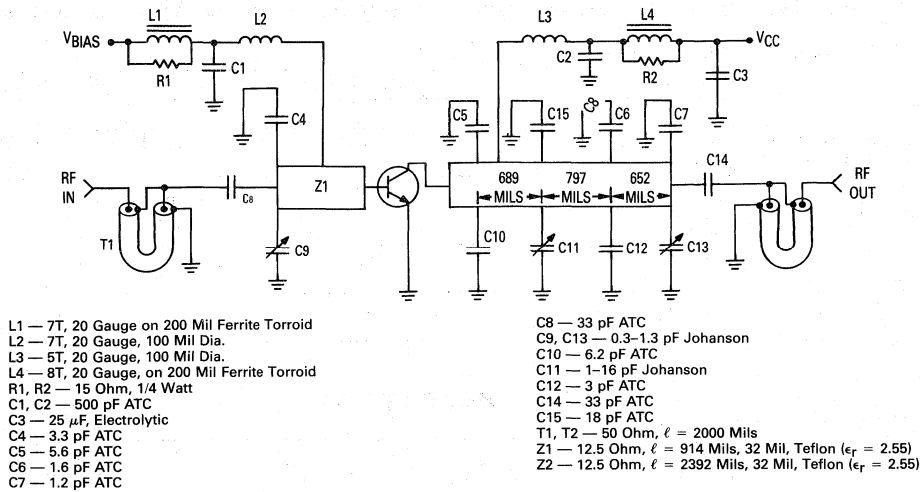


Figure 5. 1 GHz Test Circuit

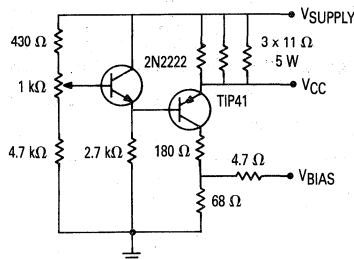
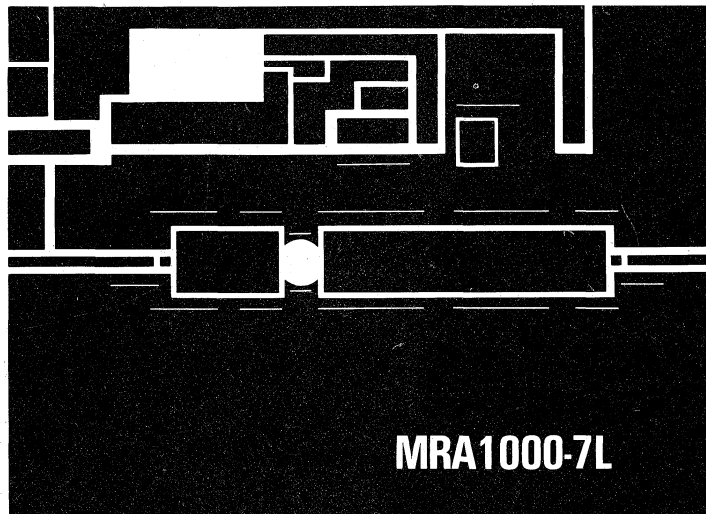


Figure 6. Bias Circuit



(Not to Scale)

Board Material = 1/32", Glass Teflon, K = 2.55

Figure 7. Test Circuit Mask

The RF Line

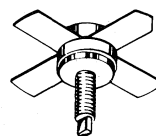
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages to 1000 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 1000 MHz Characteristics:
 - Output Power — 14 Watts
 - Power Gain — 8 dB, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MRA1000-14L

**8 dB
 TO 1000 MHz
 14 WATTS
 BROADBAND
 UHF POWER
 TRANSISTOR**



**.380 SOE
 CASE 145D-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	83 0.48	Watts $\text{W}/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	2.1	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 19\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	20	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	90	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 24\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	40	pF
--	----------	---	---	----	----

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain ($V_{CE} = 19\text{ V}$, $P_{in} = 1\text{ mW}$, $f = 1\text{ GHz}$, $I_C = 2.4\text{ A}$)	G_{SS}	8	—	—	dB
Load Mismatch ($V_{CE} = 19\text{ V}$, $I_C = 2.4\text{ A}$, $P_{out} = 14\text{ W}$, $f = 1\text{ GHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive ($V_{CE} = 19\text{ V}$, $I_C = 2.4\text{ A}$, $f = 1\text{ GHz}$) (No degradation)	P_{inover}	—	—	7	W
Output Power, 1 dB Compression Point ($V_{CE} = 19\text{ V}$, $f = 1\text{ GHz}$, $I_C = 2.4\text{ A}$)	$P_{o1\text{ dB}}$	14	—	—	W

TYPICAL CHARACTERISTICS

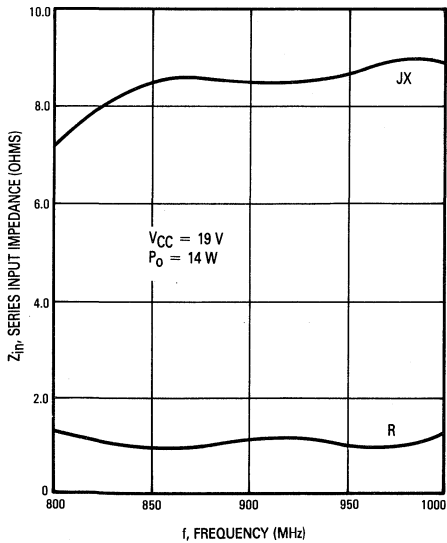


Figure 1. Input Impedance versus Frequency

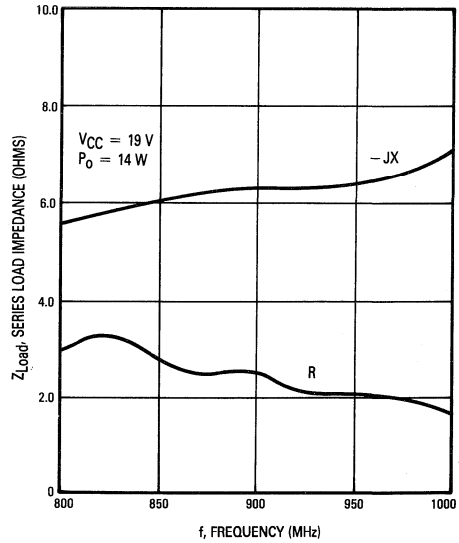


Figure 2. Load Impedance versus Frequency

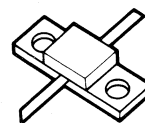
The RF Line Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 1.4 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1.4 GHz Characteristics:
 - Output Power — 2 to 35 Watts
 - Power Gain — 7 to 8.2 dB
 - Collector Efficiency — 45 to 50%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MRA1014 Series

7 to 8 dB
1–1.4 GHz
2 TO 35 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



MRA .25
CASE 394-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-2	-6	-12	-35	Unit
Collector-Base Voltage	V_{CES}	50				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1	2	5	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	-65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $V_{BE} = 0$) ($I_C = 40$ mA, $V_{BE} = 0$) ($I_C = 80$ mA, $V_{BE} = 0$) ($I_C = 200$ mA, $V_{BE} = 0$)	MRA1014-2	$V_{(BR)CES}$	50	—	—	Vdc
	-6		50	—	—	
	-12		50	—	—	
	-35		50	—	—	
Emitter-Base Breakdown Voltage ($I_E = 0.25$ mA, $I_C = 0$) ($I_E = 0.5$ mA, $I_C = 0$) ($I_E = 1$ mA, $I_C = 0$) ($I_E = 2.5$ mA, $I_C = 0$)	MRA1014-2	$V_{(BR)EBO}$	3.5	—	—	Vdc
	-6		3.5	—	—	
	-12		3.5	—	—	
	-35		3.5	—	—	
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	MRA1014-2	I_{CBO1}	—	—	0.5	mAdc
	-6		—	—	1	
	-12		—	—	2	
	-35		—	—	5	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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ON CHARACTERISTICS

DC Current Gain	MRA1014-2	h_{FE}	10	—	100	—
($I_C = 0.1$ A, $V_{CE} = 5$ V)						
($I_C = 0.2$ A, $V_{CE} = 5$ V)						
($I_C = 0.4$ A, $V_{CE} = 5$ V)						
($I_C = 1$ A, $V_{CE} = 5$ V)						
			10	—	100	
			10	—	100	
			10	—	100	
			10	—	100	

DYNAMIC CHARACTERISTICS

Output Capacitance	MRA1014-2	C_{ob}	—	—	4.5	pF
($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)						
			—	—	8	
			—	—	12	
			—	—	24 (1)	

FUNCTIONAL TESTS

Common-Base Amplifier Power Gain	MRA1014-2	G_{PB}	8.2	—	—	dB
($V_{CE} = 28$ V, $P_{out} = 2$ W, $f = 1.4$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 6$ W, $f = 1.4$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 12$ W, $f = 1.4$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 35$ W, $f = 1.4$ GHz)						
			7.4	—	—	
			7.8	—	—	
			7	—	—	
Collector Efficiency	MRA1014-2	η_c	45	—	—	%
($V_{CE} = 28$ V, $P_{out} = 2$ W, $f = 1.4$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 6$ W, $f = 1.4$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 12$ W, $f = 1.4$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 35$ W, $f = 1.4$ GHz)						
			50	—	—	
			50	—	—	
			50	—	—	

(1) Nominal value, not measurable because of shunt inductor bypass.

TYPICAL CHARACTERISTICS

MRA1014-2 — 2 WATTS BROADBAND

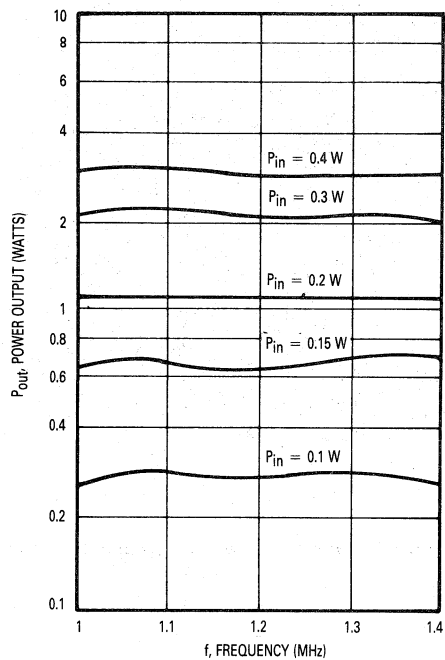


Figure 1. Power Output versus Frequency

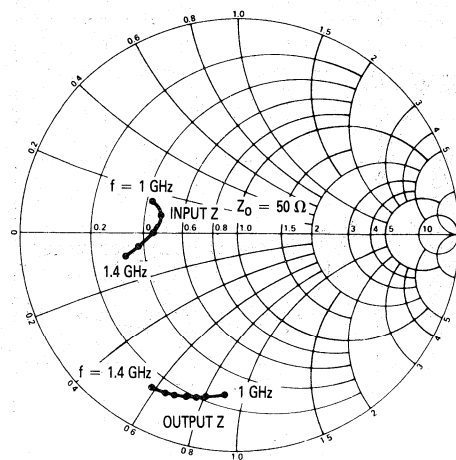
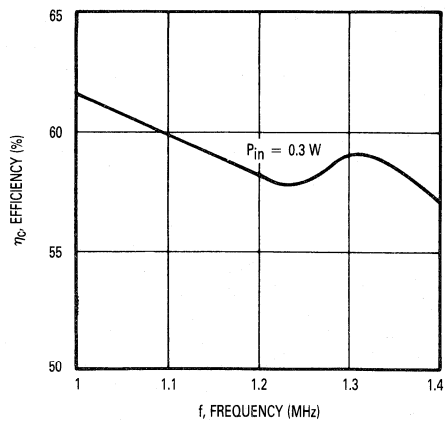
Figure 2. Series Equivalent Input/Output Impedance
 $V_{CC} = 28 \text{ V}$ 

Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA1014-6 — 6 WATTS BROADBAND

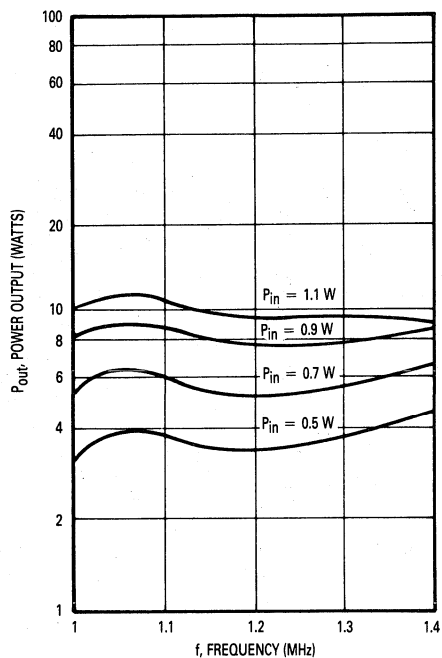


Figure 4. Power Output versus Frequency

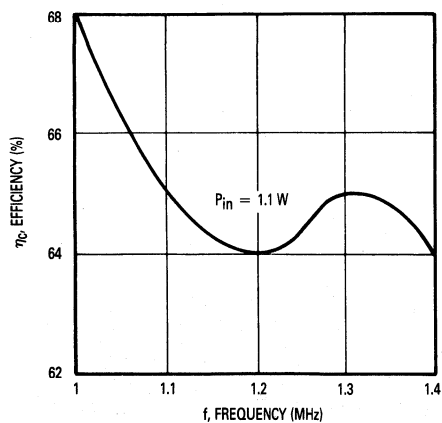
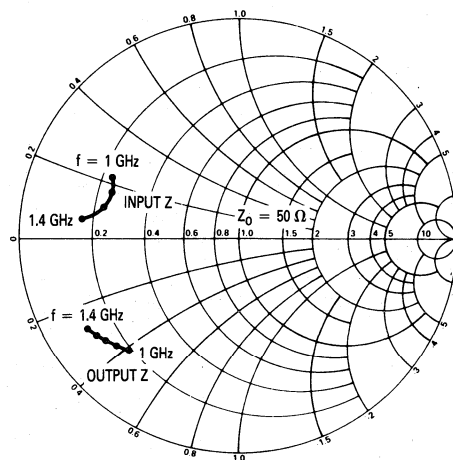


Figure 6. Efficiency versus Frequency

Figure 5. Series Equivalent Input/Output Impedance
 $V_{CC} = 28$ V

TYPICAL CHARACTERISTICS

MRA1014-12 — 12 WATTS BROADBAND

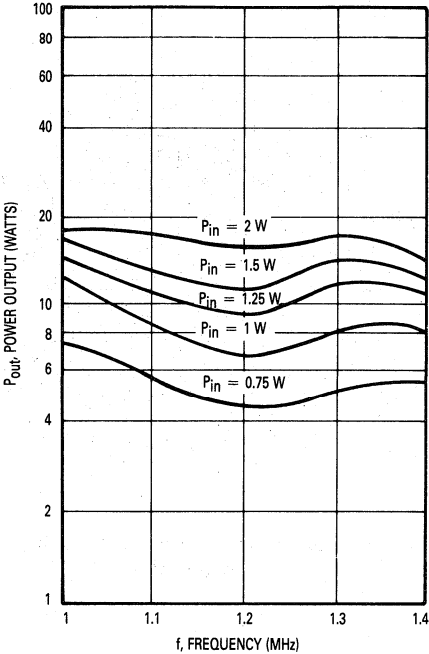


Figure 7. Power Output versus Frequency

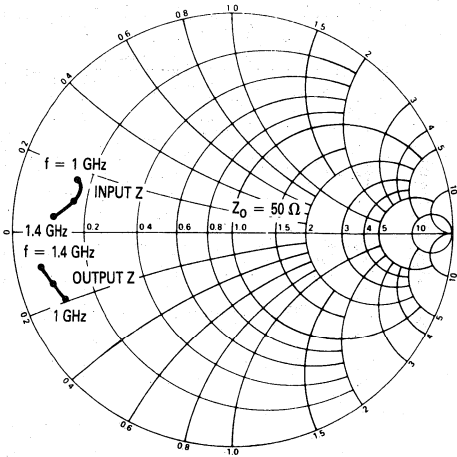


Figure 8. Series Equivalent Input/Output Impedance
 $V_{CC} = 28\text{ V}$

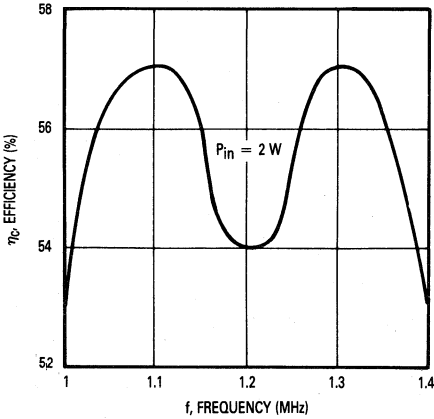


Figure 9. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA1014-35 — 35 WATTS BROADBAND

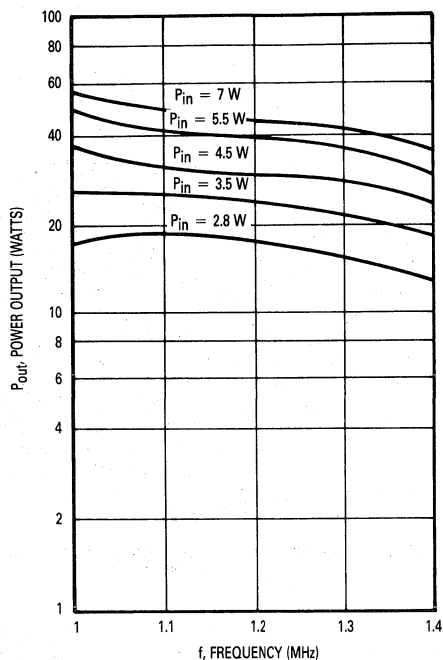


Figure 10. Power Output versus Frequency

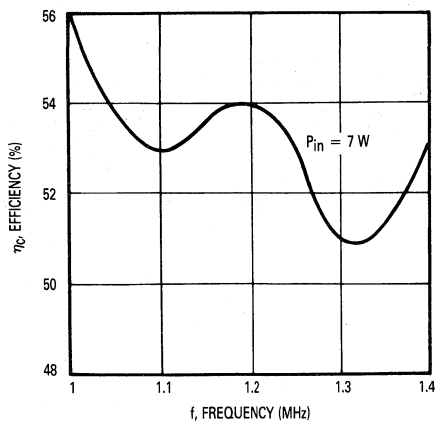
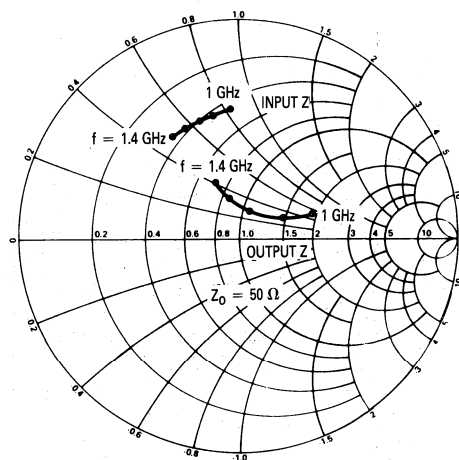
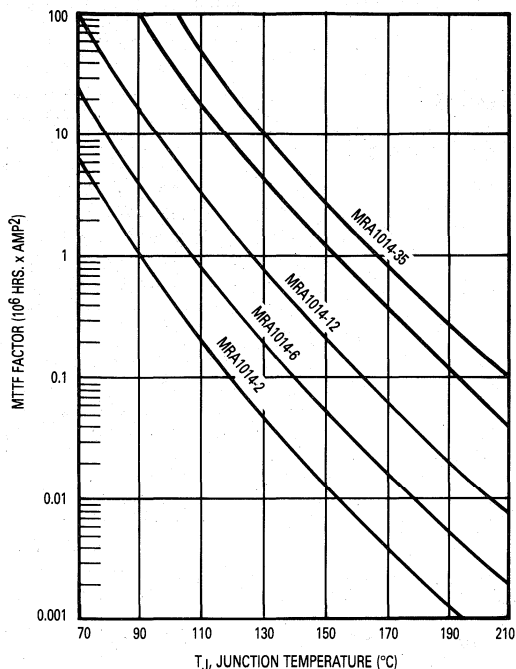


Figure 12. Efficiency versus Frequency

Figure 11. Series Equivalent Input/Output Impedance
 $V_{CC} = 28$ V

MRA1014 Series

The graph shown below displays MTTF in hours x ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



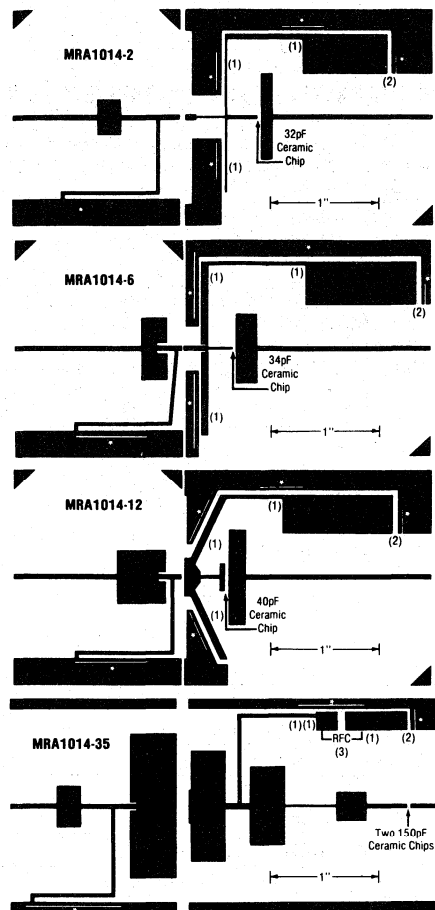
Example of MTTF for MRA1014-12 Conditions

$$\begin{aligned}
 P_o &= 12 \text{ W} \\
 P_{in} &= 2 \text{ W} \\
 V_{CC} &= 28 \text{ V} \\
 \eta &= 50 \\
 T_{FLANGE} &= 70^{\circ}\text{C} \\
 I_C &= I_E = \frac{100 \times P_o}{\eta_c \times V_{CC}} = 0.857 \text{ A} \\
 P_{DISS} &= P_{in} + V_{CC} \cdot I_C - P_o = 13.99 \text{ W} \\
 T_{JUNC} &= T_{FLANGE} + \theta_{JF} \times P_{DISS} = 132.9^{\circ}\text{C} \\
 MTTF &= \frac{0.7 \times 10^6 \text{ Hrs. Amp}^2}{I_C^2} = 953,095 \text{ Hrs} \\
 MTTF &= 108.8 \text{ Yrs}
 \end{aligned}$$

Figure 13. MTTF Factor
(Normalized to 1 Ampere² Continuous Duty)

TEST CIRCUIT BOARDS FOR MRA1014 SERIES

NOTE: Scale is not 1:1.



*Foil wrap or plate around to ground plane. Board material 0.020 inch glass-epoxy $\epsilon_r = 2.55$.
 (1) Bypass capacitor to ground (150pF chip).
 (2) Use B+ bypass of 0.01 and $1\mu\text{F}$ capacitors at this point.
 (3) 10 turns #20 enamel close wound on 0.040 mandrel.

Figure 14. Test Circuit Boards (Not to Scale)

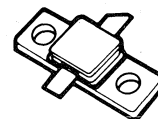
The RF Line Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 1.4 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
 - Output Power — 2 to 12 Watts
 - Power Gain — 7.4 to 8 dB
 - Collector Efficiency — 35 to 50%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

MRA1014H Series

7.4 to 8 dB
1-1.4 GHz
2 TO 12 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



HLP-11
CASE 393-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-2H	-6H	-12H	Unit
Collector-Base Voltage	V_{CES}		50		Vdc
Emitter-Base Voltage	V_{EBO}		3.5		Vdc
Collector Current — Continuous	I_C	0.5	1	2	Adc
Operating Junction Temperature	T_J		200		°C
Storage Temperature Range	T_{stg}		-65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	8	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $V_{BE} = 0$) ($I_C = 40$ mA, $V_{BE} = 0$) ($I_C = 80$ mA, $V_{BE} = 0$)	MRA1014- 2H - 6H -12H	$V_{(BR)CES}$	50 50 50	— — —	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5$ mA, $I_C = 0$) ($I_E = 1$ mA, $I_C = 0$) ($I_E = 2$ mA, $I_C = 0$)	MRA1014- 2H - 6H -12H	$V_{(BR)EBO}$	3.5 3.5 3.5	— — —	— — —	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	MRA1014- 2H - 6H -12H	I_{CBO}	— — —	— — —	0.5 1 2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mA, $V_{CE} = 5$ V) ($I_C = 200$ mA, $V_{CE} = 5$ V) ($I_C = 400$ mA, $V_{CE} = 5$ V)	MRA1014- 2H - 6H -12H	h_{FE}	10 10 10	— — —	100 100 100	—
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	MRA1014- 2H	C_{ob}	—	—	4.5	pF
	- 6H		—	—	8	
	-12H		—	—	12	

FUNCTIONAL TESTS

Common-Base Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 2\text{ W}$, $f = 1.4\text{ GHz}$) ($V_{CE} = 28\text{ V}$, $P_{out} = 6\text{ W}$, $f = 1.4\text{ GHz}$) ($V_{CE} = 28\text{ V}$, $P_{out} = 12\text{ W}$, $f = 1.4\text{ GHz}$)	MRA1014- 2H	G_{PB}	8	—	—	dB
	- 6H		7.4	—	—	
	-12H		7.8	—	—	
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 2\text{ W}$, $f = 1.4\text{ GHz}$) ($V_{CE} = 28\text{ V}$, $P_{out} = 6\text{ W}$, $f = 1.4\text{ GHz}$) ($V_{CE} = 28\text{ V}$, $P_{out} = 12\text{ W}$, $f = 1.4\text{ GHz}$)	MRA1014- 2H	η_c	35	—	—	%
	- 6H		50	—	—	
	-12H		50	—	—	

The RF Line

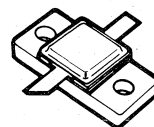
Microwave Pulse Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.2 to 1.4 GHz frequency range.

- Designed for Class C, Common-Base Pulse Power Amplifiers
- Specified 28 Volt, 1.4 GHz Characteristics:
 - Output Power — 50 W CW, Min
100 W Pulse, Typ
 - Power Gain — 6.5 dB Min, CW
 - Collector Efficiency — 45% Min, CW
- Built-In Matching Networks — Input and Output — for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

MRA1214-55H

**6.5 dB
 1.2-1.4 GHz
 50 WATTS
 MICROWAVE
 PULSE POWER
 TRANSISTOR**



**HLP-15M
 CASE 402-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	58	Vdc
Collector Current — Continuous	I_C	7.5	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	- 65 to + 200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 120$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	58	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 15$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	I_{CBO}	—	—	7.2	mAdc

FUNCTIONAL TESTS

Common-Base Amplifier Power Gain ($V_{CE} = 28$ V, $P_{out} = 50$ W CW, $f = 1.4$ GHz)	G_{PB}	6.5	—	—	dB
Collector Efficiency ($V_{CE} = 28$ V, $P_{out} = 50$ W CW, $f = 1.4$ GHz)	η	45	—	—	%
Load Mismatch ($V_{CE} = 28$ V, $P_{out} = 50$ W, $f = 1.4$ GHz, Load VSWR = 3:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

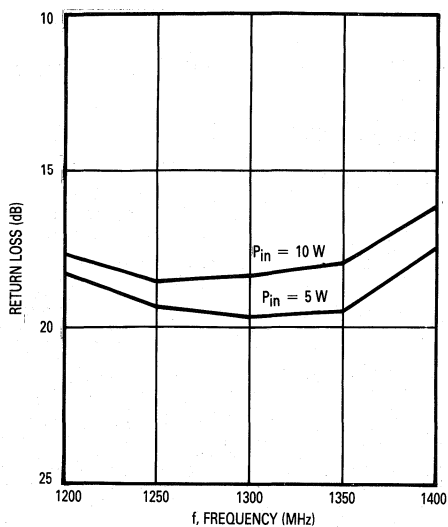


Figure 1. Loss versus Frequency

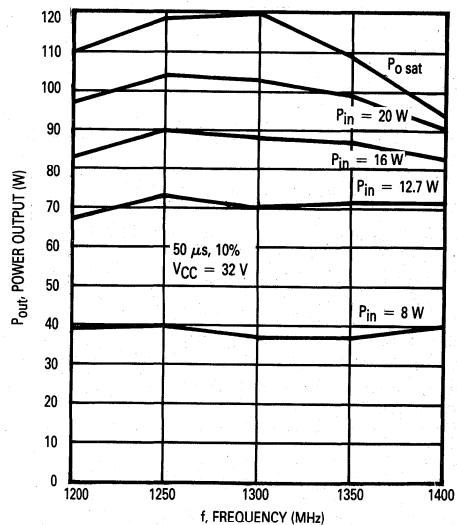


Figure 2. Power versus Frequency — Short Pulse

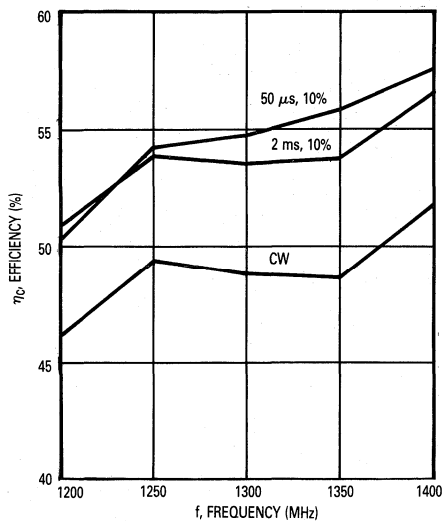


Figure 3. Efficiency versus Frequency

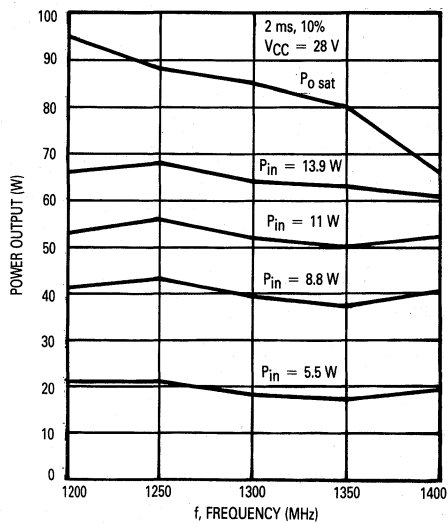
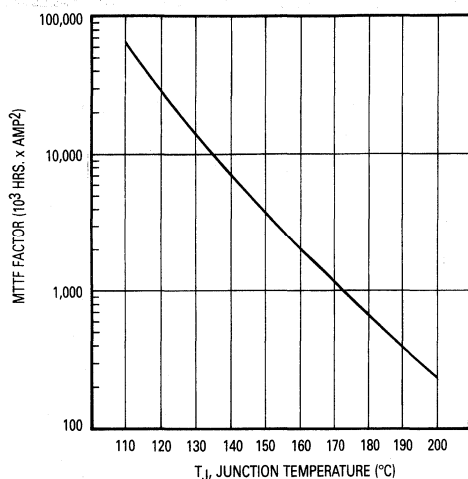


Figure 4. Power versus Frequency — Long Pulse



Note: Divide MTTF factor by I_C^2 to obtain metal lifetime in hours.

Example Calculation

For $P_O = 50$ W, $\eta_c = 45\%$
 $T_F = 50^\circ\text{C}$

$$I_C = \frac{P_O(100)}{V_{CC} \eta_c} = \frac{50(100)}{(28)(45)} = 3.97 \text{ Amp}$$

$$P_D = V_{CC} I_C - P_O + P_{in} = (28)(3.97) - 50 \text{ W} + 11.2 = 72.3 \text{ W}$$

$$T_J = \theta_{JC} P_D + T_F = 151^\circ\text{C}$$

$$\text{MTTF} \approx 254,000 \text{ Hours}$$

Figure 5. MTTF versus Junction Temperature

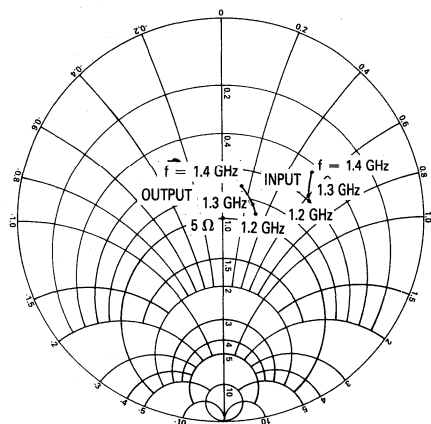


Figure 7. Series Equivalent Input/Output Impedance

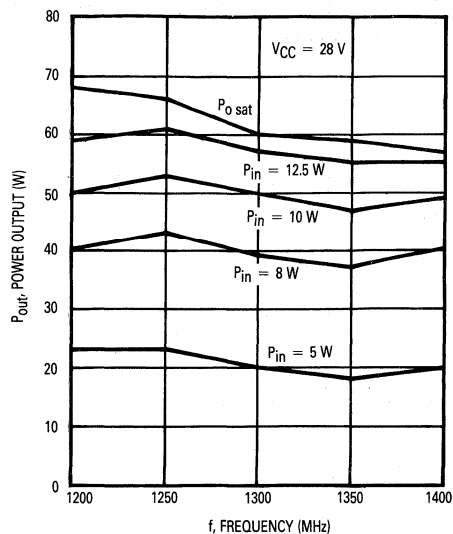
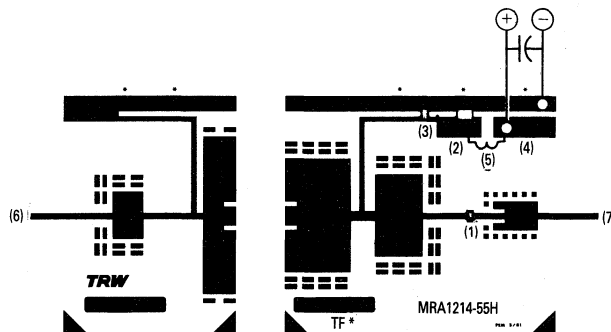


Figure 6. Power versus Frequency — CW



Note: Consult factory for artwork transparency
 PART DETAILS

NO.	PURPOSE	VALUE	DESCRIPTION
*	Foil wrapped around or through to ground.	1-2 mil.	Brass
(1)	DC blocking capacitor	100 pF	Ceramic Chip (ATC)
(2)	VCC bypass capacitor to ground.	0.1 μF	Ceramic Chip
(3)	Position to obtain maximum output power.	120 pF	Ceramic Chip
(4)	DC filter capacitor to ground.	50 μF (50 V)	Tantalum, Electrolytic
(5)	Wire inductor with Ferrite Beads.	#28 AWG	Wire
(6)	RF input connector.	50 ohms	"N" Type
(7)	RF output connector.	50 ohms	"N" Type

BOARD MATERIAL: Double-sided, 20 mil. Glass/Teflon ($\epsilon_r = 2.55$) 2 oz. Copper

SUBSTRATE MOUNTING: Solder to brass or copper heat sink (2" x 4.1" x 0.5").

Figure 8. Printed Circuit Board Layout (Not to Scale)

MRA1417
Series

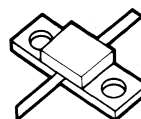
The RF Line

Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.4 to 1.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1.7 GHz Characteristics:
 - Output Power — 2 to 25 Watts
 - Power Gain — 7 to 8 dB Min
 - Collector Efficiency — 40 to 45% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

7 to 8 dB
1.4–1.7 GHz
2 TO 25 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



MRA .25
CASE 394-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-2	-6	-11	-25A	Unit
Collector-Base Voltage	V_{CES}	50				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1	4	8	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	-65 to +200				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mA}$, $V_{BE} = 0$) ($I_C = 40 \text{ mA}$, $V_{BE} = 0$) ($I_C = 80 \text{ mA}$, $V_{BE} = 0$) ($I_C = 160 \text{ mA}$, $V_{BE} = 0$)	MRA1417-2 -6 -11 -25A	$V_{(BR)CES}$	50 50 50 50	— — — —	— — — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.25 \text{ mA}$, $I_C = 0$) ($I_E = 0.5 \text{ mA}$, $I_C = 0$) ($I_E = 1 \text{ mA}$, $I_C = 0$) ($I_E = 2 \text{ mA}$, $I_C = 0$)	MRA1417-2 -6 -11 -25A	$V_{(BR)EBO}$	3.5 3.5 3.5 3.5	— — — —	— — — —	Vdc
Collector Cutoff Current ($V_{CB} = 28 \text{ V}$, $I_E = 0$)	MRA1417-2 -6 -11 -25A	I_{CBO1}	— — — —	— — — —	0.5 1 2 4	mAdc
Collector Cutoff Current ($V_{CE} = 45 \text{ V}$, $I_E = 0$)	MRA1417-2 -6 -11 -25A	I_{CBO2}	— — — —	— — — —	1 2 4 8	mAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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ON CHARACTERISTICS

DC Current Gain ($I_C = 0.1$ A, $V_{CE} = 5$ V)	MRA1417-2	h_{FE}	10	—	100	—
($I_C = 0.2$ A, $V_{CE} = 5$ V)						
($I_C = 0.4$ A, $V_{CE} = 5$ V)						
($I_C = 0.8$ A, $V_{CE} = 5$ V)						
	-6		10		100	
	-11		10		100	
	-25A		10		100	

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	MRA1417-2	C_{ob}	—	—	4.5	pF
	-6		—		8	
	-11		—		12	
	-25A		—		24 (1)	

FUNCTIONAL TESTS

Common-Base Amplifier Power Gain ($V_{CE} = 28$ V, $P_{out} = 2$ W, $f = 1.7$ GHz)	MRA1417-2	G_{PB}	8	—	—	dB
($V_{CE} = 28$ V, $P_{out} = 6$ W, $f = 1.7$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 11$ W, $f = 1.7$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 25$ W, $f = 1.7$ GHz)						
	-6		7.4		—	
	-11		7.4		—	
	-25A		7		—	
Collector Efficiency ($V_{CE} = 28$ V, $P_{out} = 2$ W, $f = 1.7$ GHz)	MRA1417-2	η_c	45	—	—	%
($V_{CE} = 28$ V, $P_{out} = 6$ W, $f = 1.7$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 11$ W, $f = 1.7$ GHz)						
($V_{CE} = 28$ V, $P_{out} = 25$ W, $f = 1.7$ GHz)						
	-6		40		—	
	-11		45		—	
	-25A		45		—	

(1) Nominal value — not measurable because of shunt inductor bypass.

TYPICAL CHARACTERISTICS
MRA1417-2 — 2 WATTS BROADBAND

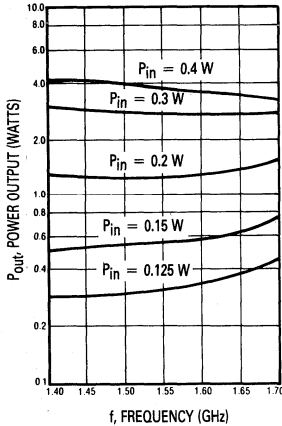


Figure 1. Power Output versus Frequency

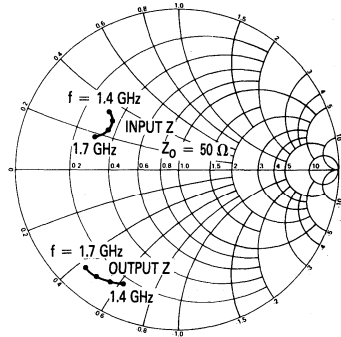


Figure 3. Series Equivalent Input/Output Impedance
 $V_{CC} = 28$ V

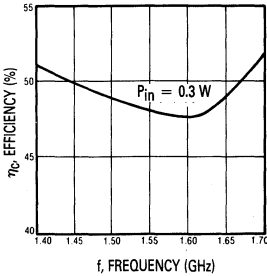


Figure 2. Efficiency versus Frequency

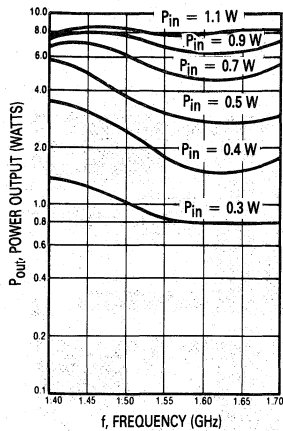


Figure 4. Power Output versus Frequency

**TYPICAL CHARACTERISTICS
MRA1417-6 — 6 WATTS BROADBAND**

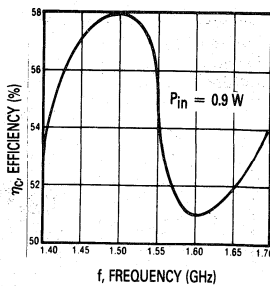
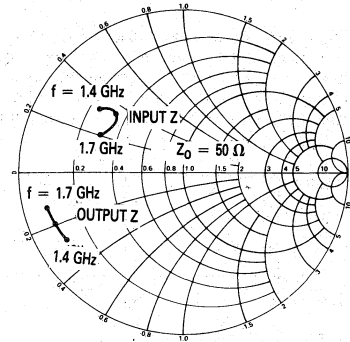


Figure 5. Efficiency versus Frequency



**Figure 6. Series Equivalent Input/Output Impedance
VCC = 28 V**

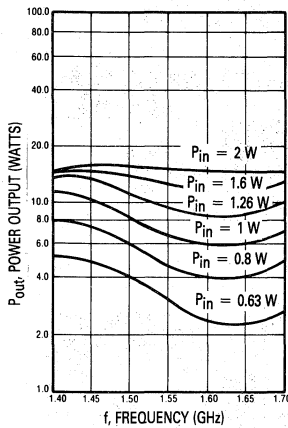


Figure 7. Power Output versus Frequency

**TYPICAL CHARACTERISTICS
MRA1417-11 — 11 WATTS BROADBAND**

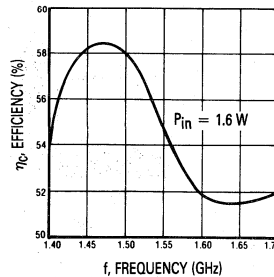
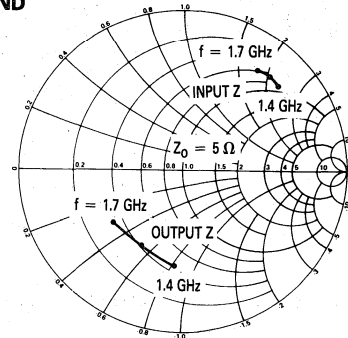


Figure 8. Efficiency versus Frequency



**Figure 9. Series Equivalent Input/Output Impedance
VCC = 28 V**

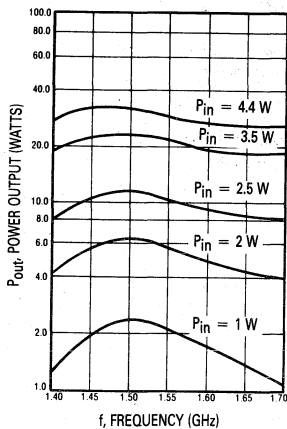


Figure 10. Power Output versus Frequency

**TYPICAL CHARACTERISTICS
MRA1417-25A — 25 WATTS BROADBAND**

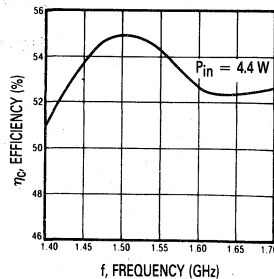
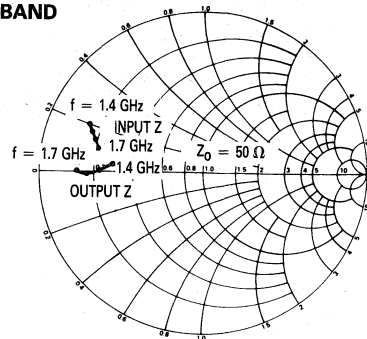
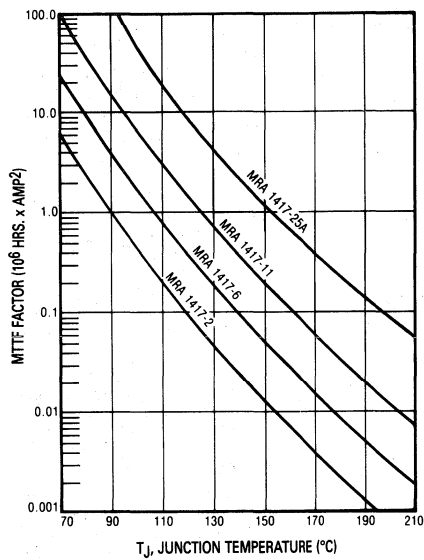


Figure 11. Efficiency versus Frequency



**Figure 12. Series Equivalent Input/Output Impedance
VCC = 28 V**

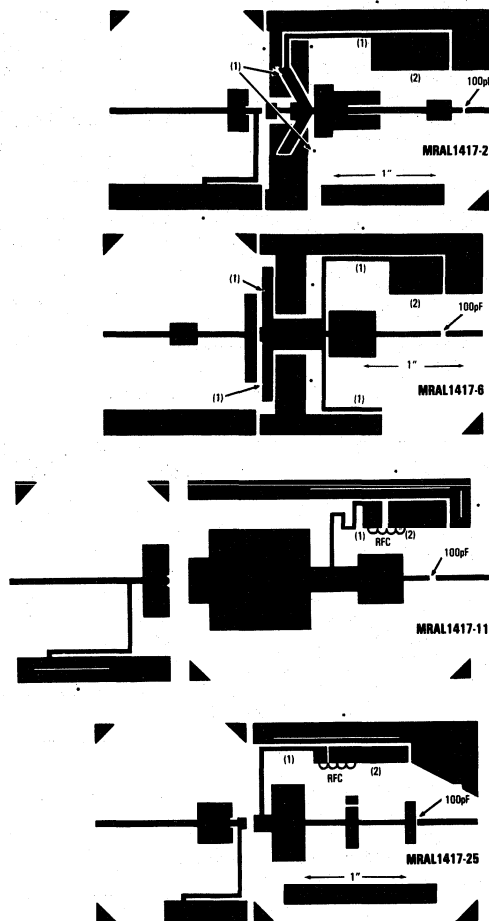
The graph shown below displays MTTF in hours x ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



Example of MTTF for MRA1417-11 Conditions

$$\begin{aligned}
 P_o &= 11 \text{ W} \\
 P_{in} &= 2 \text{ W} \\
 V_{CC} &= 28 \text{ V} \\
 \eta &= 45\% \\
 T_{FLANGE} &= 70^\circ\text{C} \\
 I_C &= I_E = \frac{100 \times P_o}{\eta_c \times V_{CC}} = 0.873 \text{ A} \\
 P_{DISS} &= P_{in} + V_{CC} \cdot I_C - P_o = 15.44 \text{ W} \\
 T_{JUNC} &= T_{FLANGE} + \theta_{JF} \times P_{DISS} = 139.4^\circ\text{C} \\
 MTTF &= \frac{0.36 \times 10^6 \text{ Hrs. Amp}^2}{I_C^2} = 472,360 \text{ Hrs} \\
 MTTF &= 53.9 \text{ Yrs}
 \end{aligned}$$

Figure 13. MTTF Factor
(Normalized to 1 Ampere² Continuous Duty)



Board material: 18 mil dielectric thickness teflon fiberglass.
*Ground through to backside ground plane.
(1) Bypass 100pF chip capacitor.
(2) Vcc bypassed by 0.1μF chip and 5μF electrolytic.

Figure 14. Test Circuit Boards
(Not to Scale)

MRA1417H
Series

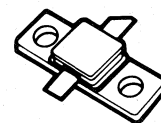
The RF Line

Microwave Power Transistors

...designed primarily for wideband, large-signal output and driver amplifier stages in the 1.4 to 1.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1.7 GHz Characteristics:
 - Output Power — 2 to 11 Watts
 - Power Gain — 7.4 to 8 dB, Min
 - Collector Efficiency — 40 to 45% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

7.4 to 8 dB
1.4–1.7 GHz
2 TO 11 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



HLP-11
CASE 393-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-2H	-6H	-11H	Unit
Collector-Base Voltage	V_{CES}	50			Vdc
Emitter-Base Voltage	V_{EBO}	3.5			Vdc
Collector Current — Continuous	I_C	0.5	1	2	Adc
Operating Junction Temperature	T_J	200			°C
Storage Temperature Range	T_{stg}	-65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	8	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $V_{BE} = 0$) ($I_C = 40$ mA, $V_{BE} = 0$) ($I_C = 80$ mA, $V_{BE} = 0$)	MRA1417- 2H - 6H -11H	$V_{(BR)CES}$	50 50 50	— — —	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.25$ mA, $I_C = 0$) ($I_E = 0.5$ mA, $I_C = 0$) ($I_E = 1$ mA, $I_C = 0$)	MRA1417- 2H - 6H -11H	$V_{(BR)EBO}$	3.5 3.5 3.5	— — —	— — —	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	MRA1417- 2H - 6H -11H	I_{CBO}	— — —	— — —	0.5 1 2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mA, $V_{CE} = 5$ V) ($I_C = 200$ mA, $V_{CE} = 5$ V) ($I_C = 400$ mA, $V_{CE} = 5$ V)	MRA1417- 2H - 6H -11H	h_{FE}	10 10 10	— — —	100 100 100	—
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(continued)

MRA1417H Series

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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DYNAMIC CHARACTERISTICS

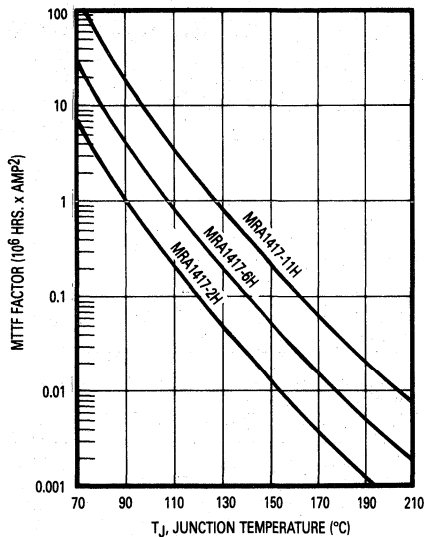
Output Capacitance ($V_{CB} = 28 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	MRA1417- 2H - 6H -11H	C_{ob}	— — —	— — —	4.5 8 12	pF
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FUNCTIONAL TESTS

Common-Base Amplifier Power Gain ($V_{CE} = 28 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 1.7 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 6 \text{ W}$, $f = 1.7 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 11 \text{ W}$, $f = 1.7 \text{ GHz}$)	MRA1417- 2H - 6H -11H	G_{PB}	8 7.4 7.4	— — —	— — —	dB
Collector Efficiency ($V_{CE} = 28 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 1.7 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 6 \text{ W}$, $f = 1.7 \text{ GHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 11 \text{ W}$, $f = 1.7 \text{ GHz}$)	MRA1417- 2H - 6H -11H	η_c	40 45 45	— — —	— — —	%

TYPICAL CHARACTERISTICS

The graph shown below displays MTTF in hours x ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



Example of MTTF for MRA1417-11H Conditions

$$\begin{aligned}
 P_o &= 11 \text{ W} \\
 P_{in} &= 2 \text{ W} \\
 V_{CC} &= 28 \text{ V} \\
 \eta &= 45\% \\
 T_{FLANGE} &= 70^\circ\text{C} \\
 I_c = I_E &= \frac{100 \times P_o}{\eta_c \times V_{CC}} = 0.873 \text{ A} \\
 P_{DISS} &= P_{in} + V_{CC} \cdot I_c - P_o = 15.44 \text{ W} \\
 T_{JUNC} &= T_{FLANGE} + \theta_{JF} \times P_{DISS} = 139.4^\circ\text{C} \\
 MTTF &= \frac{0.36 \times 10^6 \text{ Hrs. Amp}^2}{I_c^2} = 472,360 \text{ Hrs.} \\
 MTTF &= 53.9 \text{ Yrs}
 \end{aligned}$$

Figure 1. MTTF Factor
(Normalized to 1 Ampere² Continuous Duty)

The RF Line

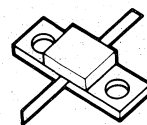
Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.7 to 2 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 2 GHz Characteristics:
 - Output Power — 2 to 20 Watts
 - Power Gain — 6 to 7.5 dB Min
 - Collector Efficiency — 35 to 40% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MRA1720 Series

6 to 7.5 dB
1.7-2 GHz
2 TO 20 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



MRA .25
CASE 394-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-2	-5	-9	-20	Unit
Collector-Base Voltage	V_{CES}	50				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1	4	8	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	-65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $V_{BE} = 0$) ($I_C = 40$ mA, $V_{BE} = 0$) ($I_C = 80$ mA, $V_{BE} = 0$) ($I_C = 160$ mA, $V_{BE} = 0$)	MRA1720-2 -5 -9 -20	$V_{(BR)CES}$	50 50 50 50	— — — —	— — — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.25$ mA, $I_C = 0$) ($I_E = 0.5$ mA, $I_C = 0$) ($I_E = 1$ mA, $I_C = 0$) ($I_E = 2$ mA, $I_C = 0$)	MRA1720-2 -5 -9 -20	$V_{(BR)EBO}$	3.5 3.5 3.5 3.5	— — — —	— — — —	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	MRA1720-2 -5 -9 -20	I_{CBO1}	— — — —	— — — —	0.5 1 2 4	mAdc
Collector Cutoff Current ($V_{CE} = 45$ V, $I_E = 0$)	MRA1720-2 -5 -9 -20	I_{CBO2}	— — — —	— — — —	1 2 4 8	mAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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ON CHARACTERISTICS

DC Current Gain ($I_C = 0.1\text{ A}$, $V_{CE} = 5\text{ V}$)	MRA1720-2	10	—	100	—
($I_C = 0.2\text{ A}$, $V_{CE} = 5\text{ V}$)	-5	10	—	100	—
($I_C = 0.4\text{ A}$, $V_{CE} = 5\text{ V}$)	-9	10	—	100	—
($I_C = 0.8\text{ A}$, $V_{CE} = 5\text{ V}$)	-20	10	—	100	—

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	MRA1720-2	—	—	4.5	pF
	-5	—	—	8	
	-9	—	—	12	
	-20	—	—	24 (1)	

FUNCTIONAL TESTS

Common-Base Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 2\text{ W}$, $f = 2\text{ GHz}$)	MRA1720-2	7.5	—	—	dB
($V_{CE} = 28\text{ V}$, $P_{out} = 5\text{ W}$, $f = 2\text{ GHz}$)	-5	6.5	—	—	
($V_{CE} = 28\text{ V}$, $P_{out} = 9\text{ W}$, $f = 2\text{ GHz}$)	-9	6.5	—	—	
($V_{CE} = 28\text{ V}$, $P_{out} = 20\text{ W}$, $f = 2\text{ GHz}$)	-20	6	—	—	
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 2\text{ W}$, $f = 2\text{ GHz}$)	MRA1720-2	35	—	—	%
($V_{CE} = 28\text{ V}$, $P_{out} = 5\text{ W}$, $f = 2\text{ GHz}$)	-5	40	—	—	
($V_{CE} = 28\text{ V}$, $P_{out} = 9\text{ W}$, $f = 2\text{ GHz}$)	-9	40	—	—	
($V_{CE} = 28\text{ V}$, $P_{out} = 20\text{ W}$, $f = 2\text{ GHz}$)	-20	40	—	—	

(1) Nominal value — not measureable because of shunt inductor bypass.

TYPICAL CHARACTERISTICS

MRA1720-2 — 2 WATTS BROADBAND

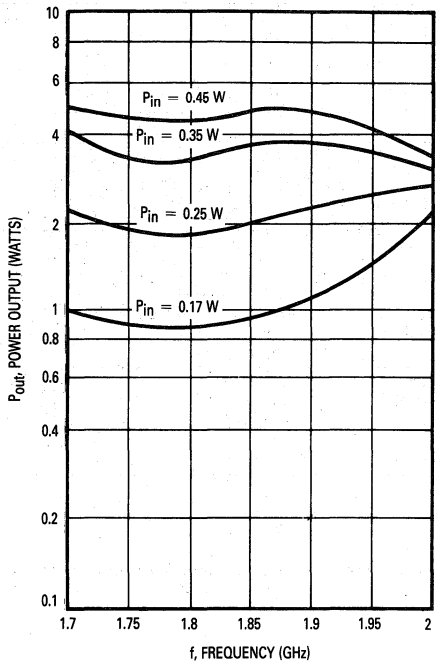


Figure 1. Power Output versus Frequency

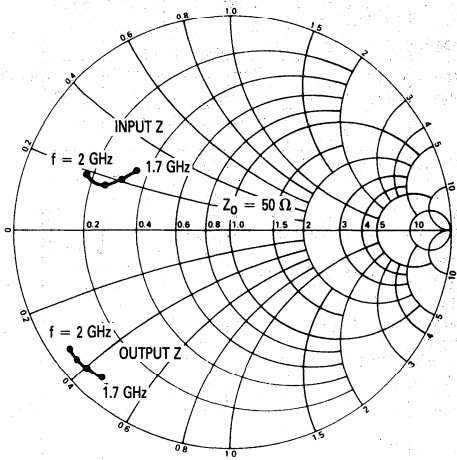


Figure 2. Series Equivalent Input/Output Impedance
 $V_{CC} = 28 \text{ V}$

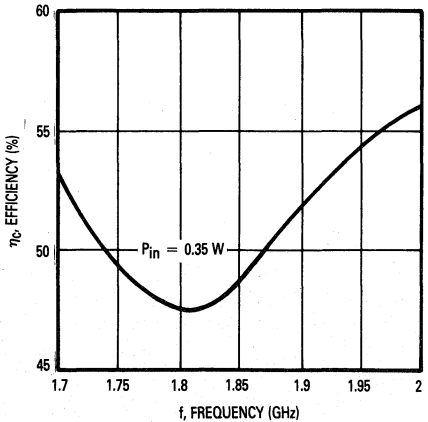


Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA1720-5 — 5 WATTS BROADBAND

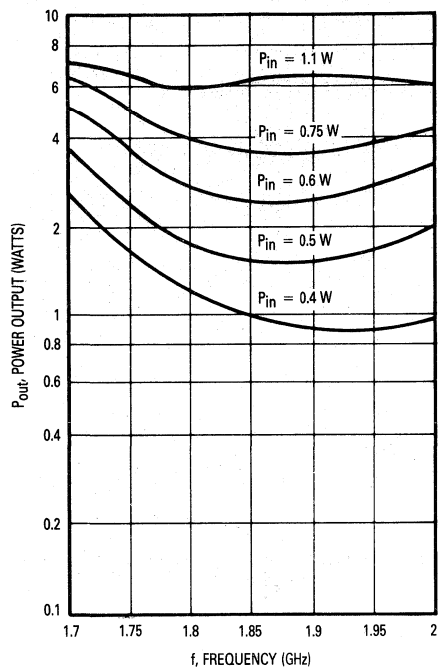


Figure 4. Power Output versus Frequency

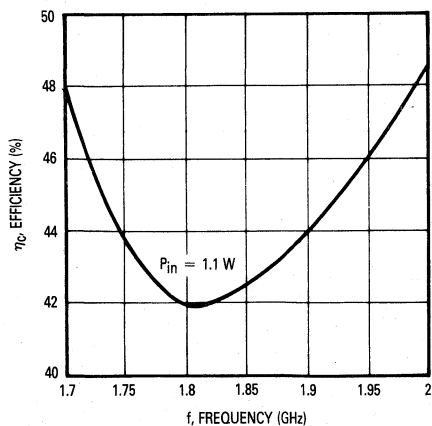
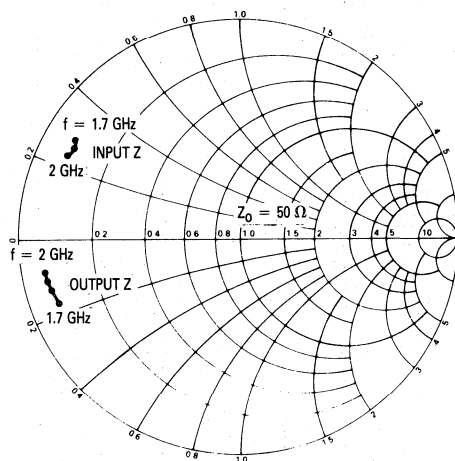


Figure 6. Efficiency versus Frequency

Figure 5. Series Equivalent Input/Output Impedance
 $V_{CC} = 28 \text{ V}$

TYPICAL CHARACTERISTICS

MRA1720-9 — 9 WATTS BROADBAND

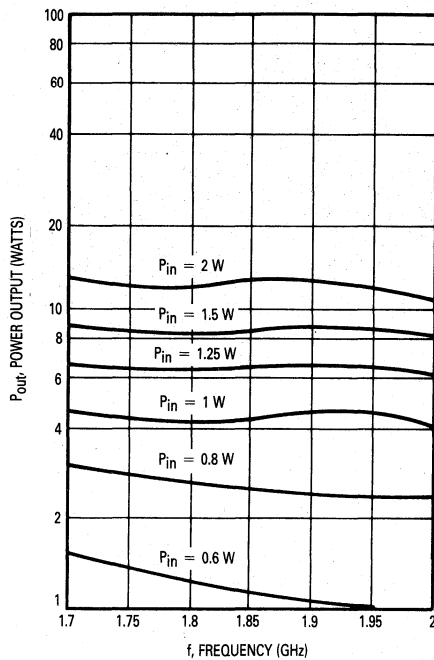


Figure 7. Power Output versus Frequency

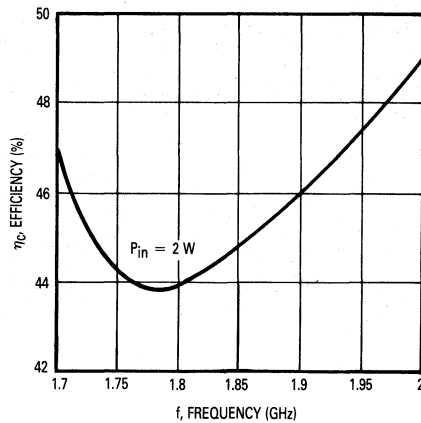
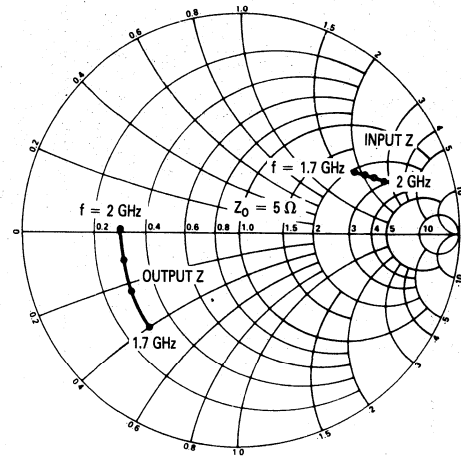


Figure 9. Efficiency versus Frequency

Figure 8. Series Equivalent Input/Output Impedance
 $V_{CC} = 28 \text{ V}$

TYPICAL CHARACTERISTICS

MRA1720-20 — 20 WATTS BROADBAND

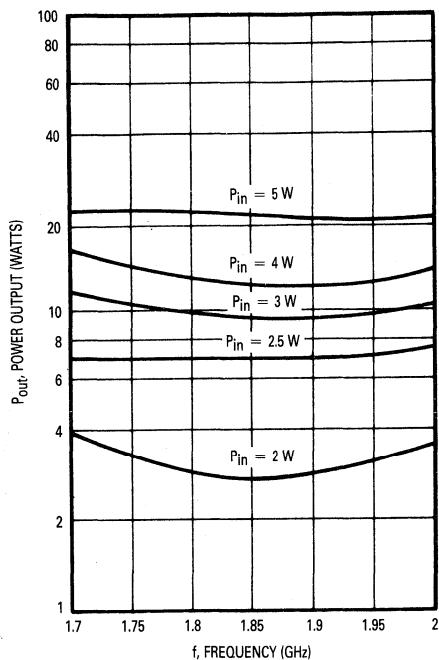


Figure 10. Power Output versus Frequency

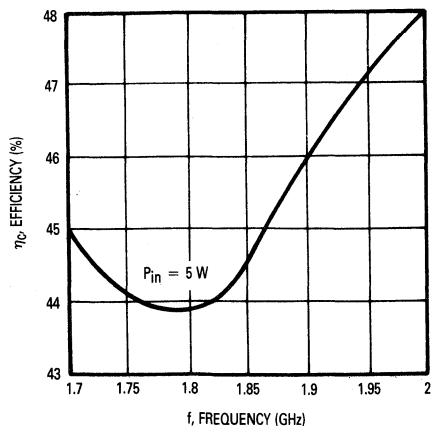
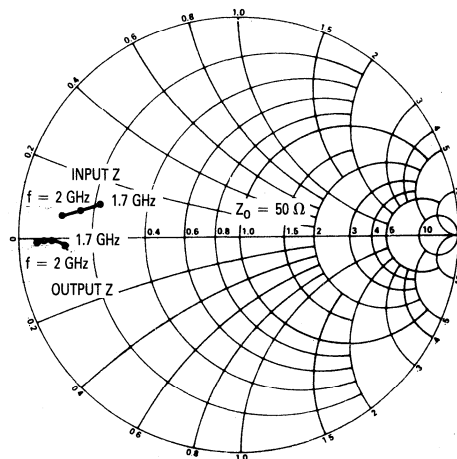
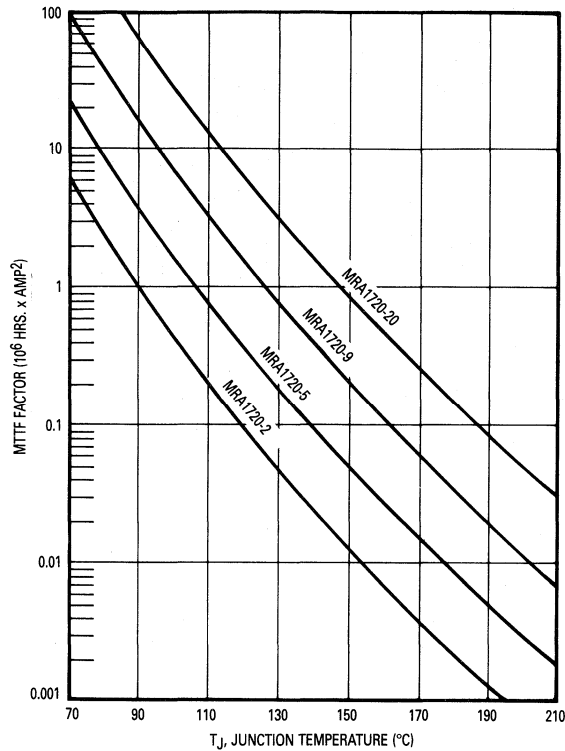


Figure 12. Efficiency versus Frequency

Figure 11. Series Equivalent Input/Output Impedance
 $V_{CC} = 28 \text{ V}$

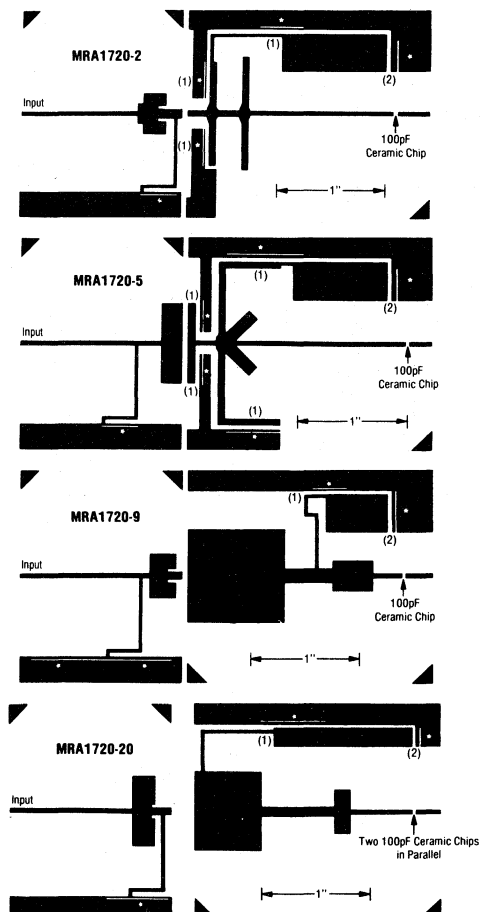
The graph shown below displays MTTF in hours x ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



Example of MTTF for MRA1720-9 Conditions

$$\begin{aligned}
 P_o &= 9 \text{ W} \\
 P_{in} &= 2 \text{ W} \\
 V_{CC} &= 28 \text{ V} \\
 \eta &= 40\% \\
 T_{FLANGE} &= 70^\circ\text{C} \\
 I_C &= I_C = \frac{100 \times P_o}{\eta \times V_{CC}} = 0.803 \text{ A} \\
 P_{DISS} &= P_{in} + V_{CC} \cdot I_C - P_o = 15.48 \text{ W} \\
 T_{JUNC} &= T_{FLANGE} + \theta_{JF} \times 15.48 = 139.6^\circ\text{C} \\
 MTTF &= \frac{0.4 \times 10^6 \text{ Hrs. Amp}^2}{I_C^2} = 620,338 \text{ Hrs} \\
 MTTF &= 70.8 \text{ Yrs}
 \end{aligned}$$

Figure 13. MTTF Factor versus Junction Temperature



*Foil wrap or plate around to ground plane.
 (1) Bypass capacitor to ground (100pF ceramic chip).
 (2) Use Vcc bypass of 100pF chip, 0.1μF chip and 5μF.
 Board material 0.020 inch glass-telton $\epsilon_r = 2.55$.

Figure 14. Test Circuit Boards (Not to Scale)

The RF Line

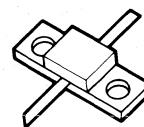
Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.4 to 1.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 1.7 GHz Characteristics:
 - Output Power — 2 to 25 Watts
 - Power Gain — 7 to 8 dB Min
 - Collector Efficiency — 40 to 45%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MRAL1417
Series

7 to 8 dB
1.4-1.7 GHz
2 TO 25 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



MRA .25
CASE 394-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-2	-6	-11	-25	Unit
Collector-Base Voltage	V _{CES}	42				V _{dc}
Emitter-Base Voltage	V _{EBO}	3.5				V _{dc}
Collector Current — Continuous	I _C	0.5	1	4	8	A _{dc}
Operating Junction Temperature	T _J	200				°C
Storage Temperature Range	T _{stg}	-65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	R _{θJC}	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (I _C = 20 mA, V _{BE} = 0) (I _C = 40 mA, V _{BE} = 0) (I _C = 80 mA, V _{BE} = 0) (I _C = 160 mA, V _{BE} = 0)	MRAL1417-2 -6 -11 -25	V _{(BR)CES}	42 42 42 42	— — — —	— — — —	V _{dc}
Emitter-Base Breakdown Voltage (I _E = 0.25 mA, I _C = 0) (I _E = 0.5 mA, I _C = 0) (I _E = 1 mA, I _C = 0) (I _E = 2 mA, I _C = 0)	MRAL1417-2 -6 -11 -25	V _{(BR)EBO}	3.5 3.5 3.5 3.5	— — — —	— — — —	V _{dc}
Collector Cutoff Current (V _{CB} = 22 V, I _E = 0)	MRAL1417-2 -6 -11 -25	I _{CBO1}	— — — —	— — — —	0.5 1 2 4	mA _{dc}
Collector Cutoff Current (V _{CE} = 38 V, V _{BE} = 0)	MRAL1417-2 -6 -11 -25	I _{CBO2}	— — — —	— — — —	1 2 4 8	mA _{dc}

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I _C = 0.1 A, V _{CE} = 5 V) (I _C = 0.2 A, V _{CE} = 5 V) (I _C = 0.4 A, V _{CE} = 5 V) (I _C = 0.8 A, V _{CE} = 5 V)	MRAL1417-2 hFE	10 10 10 10	— — — —	100 100 100 100	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V _{CE} = 22 V, P _{out} = 2 W, f = 1.7 GHz) (V _{CE} = 22 V, P _{out} = 6 W, f = 1.7 GHz) (V _{CE} = 22 V, P _{out} = 11 W, f = 1.7 GHz) (V _{CE} = 22 V, P _{out} = 25 W, f = 1.7 GHz)	MRAL1417-2 GPB	8 7.4 7.4 7	— — — —	— — — —	dB
Collector Efficiency (V _{CE} = 22 V, P _{out} = 2 W, f = 1.7 GHz) (V _{CE} = 22 V, P _{out} = 6 W, f = 1.7 GHz) (V _{CE} = 22 V, P _{out} = 11 W, f = 1.7 GHz) (V _{CE} = 22 V, P _{out} = 25 W, f = 1.7 GHz)	MRAL1417-2 η _c	45 40 45 45	— — — —	— — — —	%

TYPICAL CHARACTERISTICS

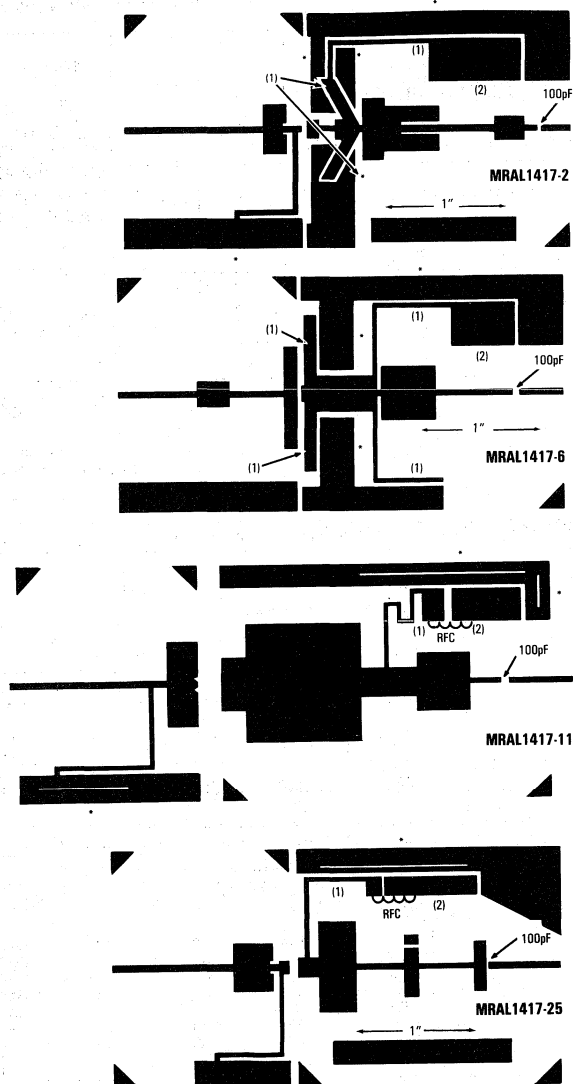
MRAL1417-2 Device Impedance					
Freq.	Z _{OUT} (Ω)		Z _{IN} (Ω)		
	R	jx	R	jx	
1.4GHz	6.17	-18.8	19.2	12.7	
1.45GHz	6.67	-19.0	18.3	12.4	
1.5GHz	7.08	-19.1	17.4	12.1	
1.55GHz	7.25	-18.9	16.6	11.9	
1.6GHz	7.14	-18.8	15.9	11.6	
1.65GHz	6.71	-18.7	15.2	11.3	
1.7GHz	6.00	-18.8	14.5	11.1	

MRAL1417-11 Device Impedance					
Freq.	Z _{OUT} (Ω)		Z _{IN} (Ω)		
	R	jx	R	jx	
1.4GHz	3.40	-4.15	5.46	11.9	
1.45GHz	4.28	-3.90	5.09	1.1	
1.5GHz	5.17	-3.32	4.76	10.4	
1.55GHz	5.42	-2.09	4.45	9.78	
1.6GHz	4.73	-1.00	4.22	9.17	
1.65GHz	3.71	-0.56	3.98	8.63	
1.7GHz	2.77	-0.66	3.80	8.08	

MRAL1417-6 Device Impedance					
Freq.	Z _{OUT} (Ω)		Z _{IN} (Ω)		
	R	jx	R	jx	
1.4GHz	8.18	-9.16	13.8	11.2	
1.45GHz	8.27	-8.05	13.9	10.4	
1.5GHz	7.86	-7.23	14.2	9.77	
1.55GHz	7.25	-6.72	14.6	9.23	
1.6GHz	6.55	-6.54	15.2	8.75	
1.65GHz	5.89	-6.53	15.9	8.49	
1.7GHz	5.23	-6.78	16.8	8.42	

MRAL1417-25 Device Impedance					
Freq.	Z _{OUT} (Ω)		Z _{IN} (Ω)		
	R	jx	R	jx	
1.4GHz	6.74	3.80	7.76	6.47	
1.45GHz	6.45	3.61	7.33	5.80	
1.5GHz	6.14	3.41	6.70	5.16	
1.55GHz	5.71	3.16	6.62	4.56	
1.6GHz	5.41	2.90	6.34	3.96	
1.65GHz	5.09	2.61	6.09	3.44	
1.7GHz	4.77	2.34	5.88	2.95	

Figure 1. Z_{IN} and Z_{OUT} versus Frequency



Board material : 18 mil dielectric thickness teflon fiberglass.

*Ground through to backside ground plane.

(1) Bypass 100pF chip capacitor.

(2) Vcc bypassed by 0.1μF chip and 5μF electrolytic.

Figure 2. Test Circuit Boards (Not to Scale)

MRAL1720
Series

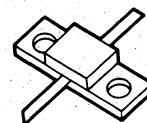
The RF Line

Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.7 to 2 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2 GHz Characteristics:
 - Output Power — 2 to 20 Watts
 - Power Gain — 6 to 7.5 dB, Min
 - Collector Efficiency — 35 to 40%, Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

6 to 7.5 dB
 1.7–2 GHz
 2 TO 20 WATTS
 BROADBAND
 MICROWAVE POWER
 TRANSISTORS



MRA .25
 CASE 394-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-2	-5	-9	-20	Unit
Collector-Base Voltage	V _{CES}	42				V _{dc}
Emitter-Base Voltage	V _{EBO}	3.5				V _{dc}
Collector Current — Continuous	I _C	0.5	1	4	8	A _{dc}
Operating Junction Temperature	T _J	200				°C
Storage Temperature Range	T _{stg}	- 65 to + 150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	R _{θJC}	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (I _C = 20 mA, V _{BE} = 0)	MRAL1720-2	V _{(BR)CES}	42	—	—	V _{dc}
(I _C = 40 mA, V _{BE} = 0)	-5		42	—	—	
(I _C = 80 mA, V _{BE} = 0)	-9		42	—	—	
(I _C = 160 mA, V _{BE} = 0)	-20		42	—	—	
Emitter-Base Breakdown Voltage (I _E = 0.25 mA, I _C = 0)	MRAL1720-2	V _{(BR)EBO}	3.5	—	—	V _{dc}
(I _E = 0.5 mA, I _C = 0)	-5		3.5	—	—	
(I _E = 1 mA, I _C = 0)	-9		3.5	—	—	
(I _E = 2 mA, I _C = 0)	-20		3.5	—	—	
Collector Cutoff Current (V _{CB} = 22 V, I _E = 0)	MRAL1720-2	I _{CBO1}	—	—	0.5	mA _{dc}
	-5		—	—	1	
	-9		—	—	2	
	-20		—	—	4	
Collector Cutoff Current (V _{CE} = 38 V, I _E = 0)	MRAL1720-2	I _{CBO2}	—	—	1	mA _{dc}
	-5		—	—	2	
	-9		—	—	4	
	-20		—	—	8	

(continued)

MRAL1720 Series

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

ON CHARACTERISTICS

DC Current Gain		h_{FE}				—
($I_C = 0.1$ A, $V_{CE} = 5$ V)	MRAL1720-2		10	—	100	
($I_C = 0.2$ A, $V_{CE} = 5$ V)	-5		10	—	100	
($I_C = 0.4$ A, $V_{CE} = 5$ V)	-9		10	—	100	
($I_C = 0.8$ A, $V_{CE} = 5$ V)	-20		10	—	100	

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	MRAL1720-2	C_{ob}	—	—	4.5	pF
	-5	—	—	—	8	
	-9	—	—	—	12	
	-20	—	—	—	24 (1)	

FUNCTIONAL TESTS

Common-Base Amplifier Power Gain ($V_{CE} = 22$ V, $P_{out} = 2$ W, $f = 2$ GHz)	MRAL1720-2	G_{pB}	7.5	—	—	dB
($V_{CE} = 22$ V, $P_{out} = 5$ W, $f = 2$ GHz)	-5	6.5	—	—	—	
($V_{CE} = 22$ V, $P_{out} = 9$ W, $f = 2$ GHz)	-9	6.5	—	—	—	
($V_{CE} = 22$ V, $P_{out} = 20$ W, $f = 2$ GHz)	-20	6	—	—	—	
Collector Efficiency ($V_{CE} = 22$ V, $P_{out} = 2$ W, $f = 2$ GHz)	MRAL1720-2	η_c	45	—	—	%
($V_{CE} = 22$ V, $P_{out} = 5$ W, $f = 2$ GHz)	-5	40	—	—	—	
($V_{CE} = 22$ V, $P_{out} = 9$ W, $f = 2$ GHz)	-9	40	—	—	—	
($V_{CE} = 22$ V, $P_{out} = 20$ W, $f = 2$ GHz)	-20	40	—	—	—	

(1) Nominal value — not measurable because of shunt inductor bypass.

TYPICAL CHARACTERISTICS MRAL1720-2

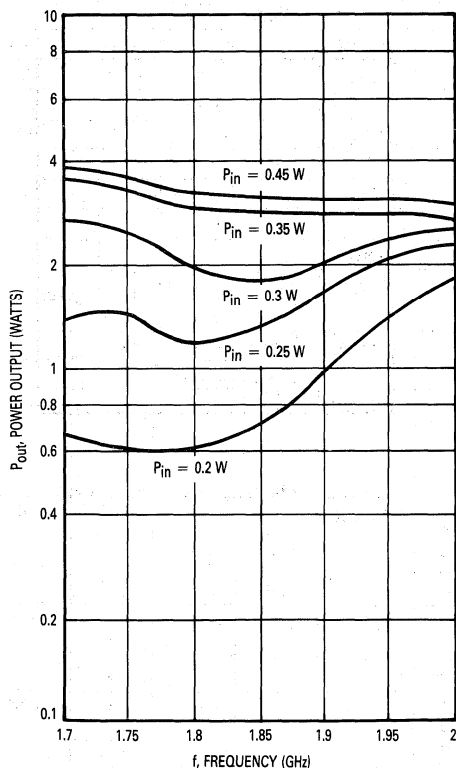


Figure 1. Power Output versus Frequency

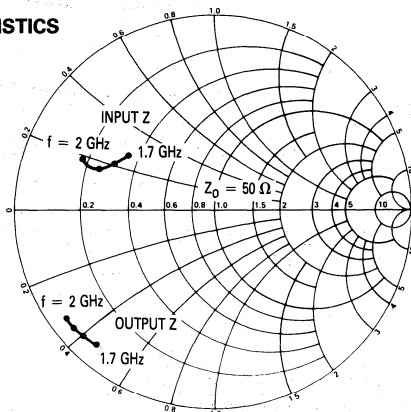


Figure 2. Series Equivalent Input/Output Impedance
 $V_{CC} = 22$ V

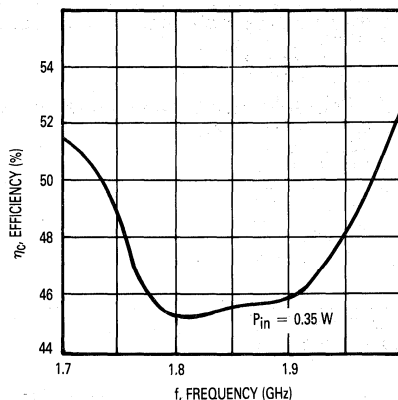


Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRAL1720-5

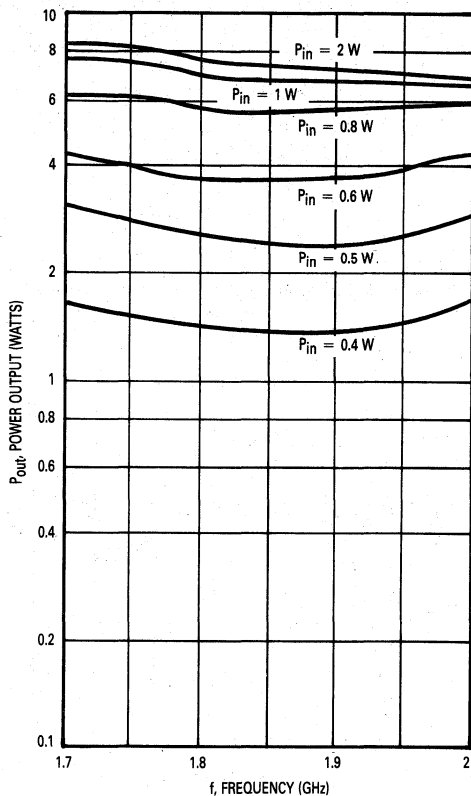


Figure 4. Power Output versus Frequency

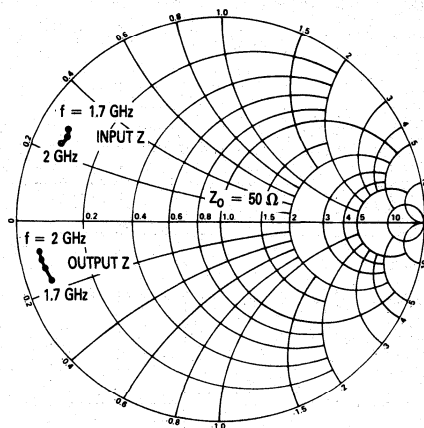


Figure 5. Series Equivalent Input/Output Impedance
 $V_{CC} = 22 \text{ V}$

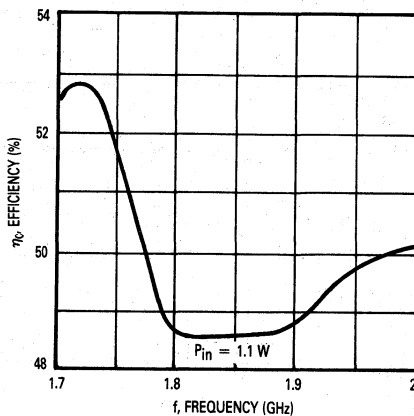


Figure 6. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRAL1720-9

2

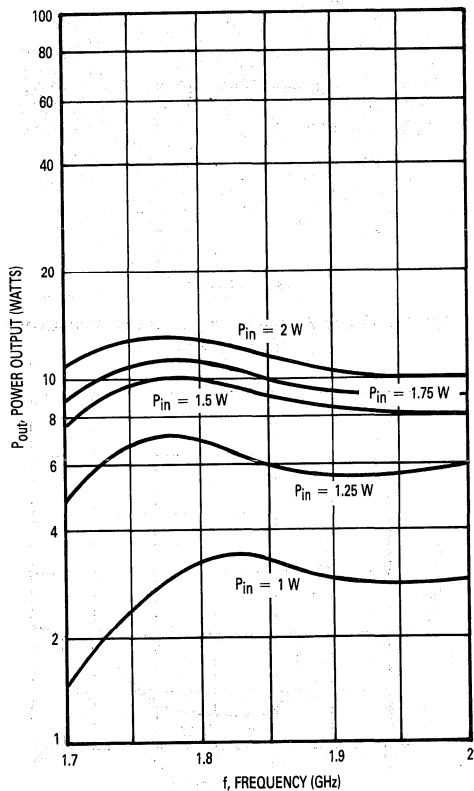


Figure 7. Power Output versus Frequency

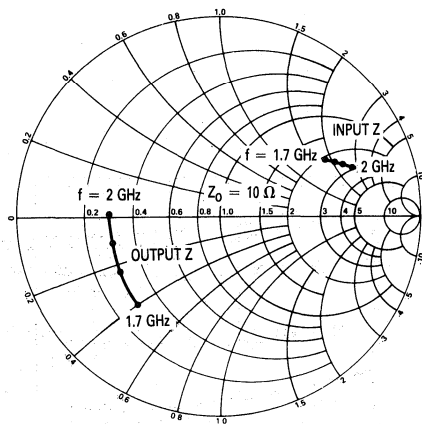


Figure 8. Series Equivalent Input/Output Impedance
 $V_{CC} = 22 \text{ V}$
 $V_{CC} = 22 \text{ V}$

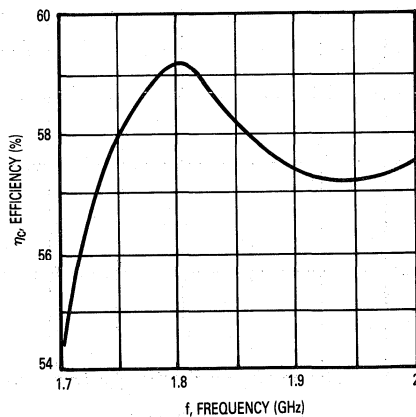


Figure 9. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRAL1720-20

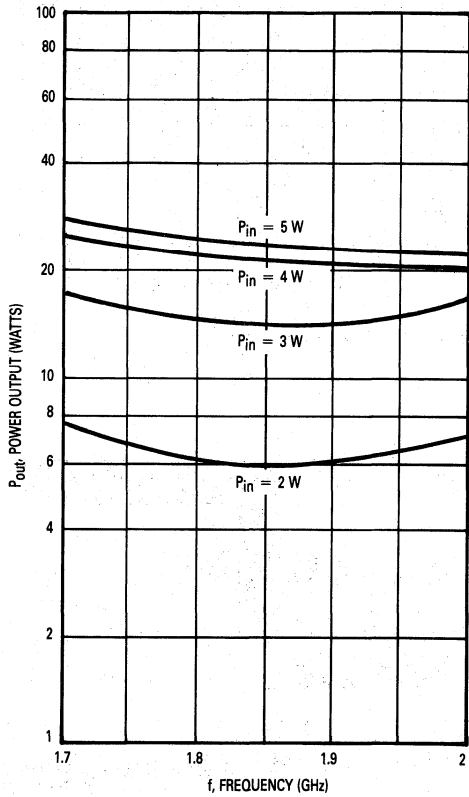


Figure 10. Power Output versus Frequency

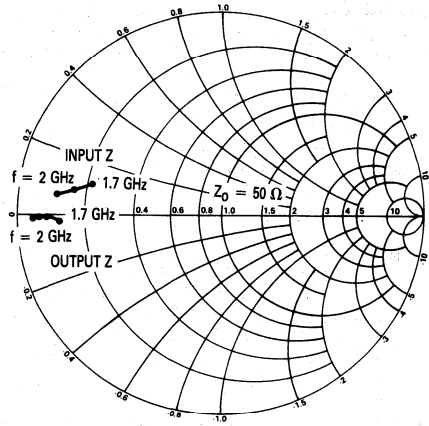


Figure 11. Series Equivalent Input/Output Impedance
 $V_{CC} = 22 \text{ V}$

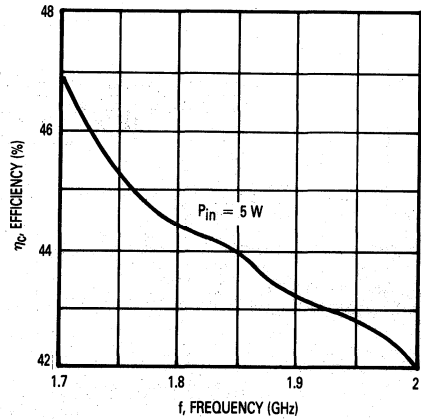


Figure 12. Efficiency versus Frequency

MRAL1720 Series

The graph shown displays MTTF in hours x ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.

Example of MTTF for MRA1720-9 Conditions

$$\begin{aligned}
 P_O &= 9 \text{ W} \\
 P_{in} &= 2 \text{ W} \\
 V_{CC} &= 28 \text{ V} \\
 \eta &= 40\% \\
 T_{FLANGE} &= 70^\circ\text{C} \\
 I_C = I_E &= \frac{100 \times P_O}{\eta_C \times V_{CC}} = 0.803 \text{ A} \\
 P_{DISS} &= P_{in} + V_{CC} \cdot I_C - B = 15.48 \text{ W} \\
 T_{JUNC} &= T_{FLANGE} + \theta_{JF} \times 15.48 = 139.6^\circ\text{C} \\
 MTTF &= \frac{0.4 \times 10^6 \text{ Hrs. Amp}^2}{I_C^2} = 620,338 \text{ Hrs} \\
 MTTF &= 70.8 \text{ Yrs}
 \end{aligned}$$

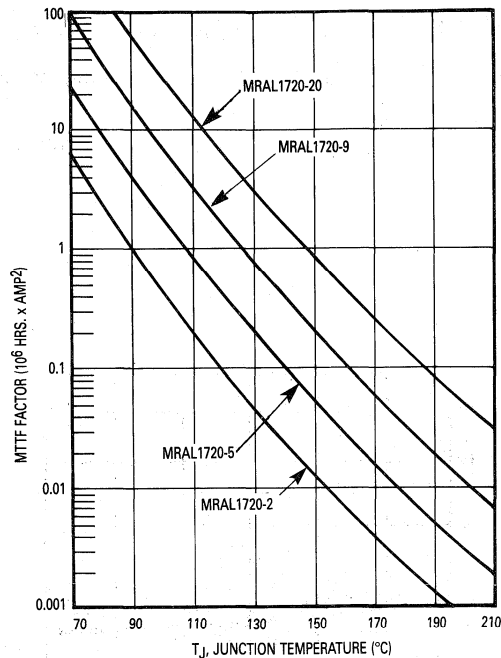
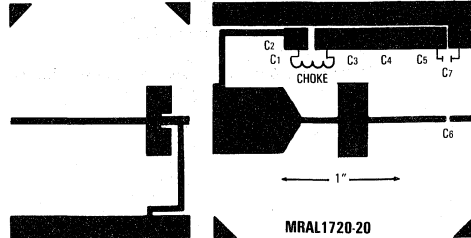
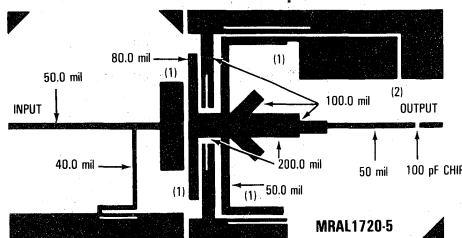
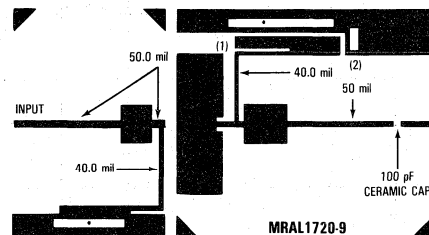
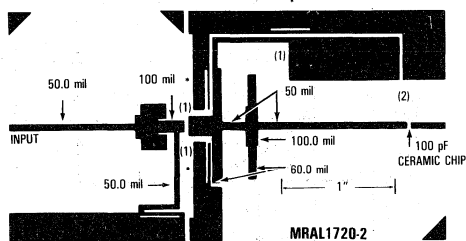


Figure 13. MTTF Factor versus Junction Temperature



*Foil wrap or plate around to ground plane.
 (1) Bypass capacitor to ground (100 pF ceramic chip).
 (2) Use V_{CC} bypass of 100 pF chip, 0.1 μF chip and 5 μF .
 Board material 0.020 inch glass-terfon $\epsilon_r = 2.55$.

- 1) C1, C5 = 0.1 μF chip capacitor
- 2) C2, C3, C4 = 120 pF
- 3) C6 = 100 pF (ATC)
- 4) C7 = 50 μF 50 WV Electrolytic
- 5) * = 1 mil Shim thru ground plane
- 6) Material = Glass/Teflon
 $\epsilon_r = 2.55$
 Thickness = .020 in.
 1.0 oz copper

Figure 14. Test Circuit Boards (Not to Scale)

The RF Line

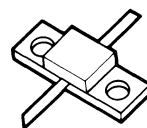
Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 2.3 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.3 GHz Characteristics:
 - Output Power — 1.5 to 12 Watts
 - Power Gain — 6.8 to 8 dB Min
 - Collector Efficiency — 35 to 40% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MRAL2023 Series

6.8 to 8 dB
2-2.3 GHz
1.5 TO 12 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



MRA .25
CASE 394-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-1.5	-3	-6	-12	Unit
Collector-Base Voltage	V_{CES}	42				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.25	0.5	1.25	2.5	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	-65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	30	16	8	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $V_{BE} = 0$) ($I_C = 20$ mA, $V_{BE} = 0$) ($I_C = 50$ mA, $V_{BE} = 0$) ($I_C = 100$ mA, $V_{BE} = 0$)	MRAL2023-1.5 -3 -6 -12	$V_{(BR)CES}$	42 42 42 42	— — — —	— — — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.2$ mA, $I_C = 0$) ($I_E = 0.4$ mA, $I_C = 0$) ($I_E = 1$ mA, $I_C = 0$) ($I_E = 2$ mA, $I_C = 0$)	MRAL2023-1.5 -3 -6 -12	$V_{(BR)EBO}$	3.5 3.5 3.5 3.5	— — — —	— — — —	Vdc
Collector Cutoff Current ($V_{CB} = 22$ V, $I_E = 0$)	MRAL2023-1.5 -3 -6 -12	I_{CBO1}	— — — —	— — — —	0.25 0.5 1.25 2.5	mAdc
Collector Cutoff Current ($V_{CE} = 38$ V, $I_E = 0$)	MRAL2023-1.5 -3 -6 -12	I_{CBO2}	— — — —	— — — —	0.5 1 2.5 5	mAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
($I_C = 0.1$ A, $V_{CE} = 5$ V)	MRAL2023-1.5		10	—	90	
($I_C = 0.2$ A, $V_{CE} = 5$ V)	-3		10	—	90	
($I_C = 0.5$ A, $V_{CE} = 5$ V)	-6		10	—	90	
($I_C = 1$ A, $V_{CE} = 5$ V)	-12		10	—	90	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRAL2023-1.5	C_{ob}	—	—	3.5	pF
($V_{CB} = 22$ V, $I_E = 0$, $f = 1$ MHz)	-3		—	—	5	
	-6		—	—	10	
	-12		—	—	20 (1)	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
($V_{CE} = 22$ V, $P_{out} = 1.5$ W, $f = 2.3$ GHz)	MRAL2023-1.5		8	—	—	
($V_{CE} = 22$ V, $P_{out} = 3$ W, $f = 2.3$ GHz)	-3		8	—	—	
($V_{CE} = 22$ V, $P_{out} = 6$ W, $f = 2.3$ GHz)	-6		6.8	—	—	
($V_{CE} = 22$ V, $P_{out} = 12$ W, $f = 2.3$ GHz)	-12		6.8	—	—	
Collector Efficiency		η_c				%
($V_{CE} = 22$ V, $P_{out} = 1.5$ W, $f = 2.3$ GHz)	MRAL2023-1.5		35	—	—	
($V_{CE} = 22$ V, $P_{out} = 3$ W, $f = 2.3$ GHz)	-3		40	—	—	
($V_{CE} = 22$ V, $P_{out} = 6$ W, $f = 2.3$ GHz)	-6		40	—	—	
($V_{CE} = 22$ V, $P_{out} = 12$ W, $f = 2.3$ GHz)	-12		40	—	—	

(1) Nominal value — not measurable because of shunt inductor bypass.

TYPICAL CHARACTERISTICS
MRAL2023-1.5

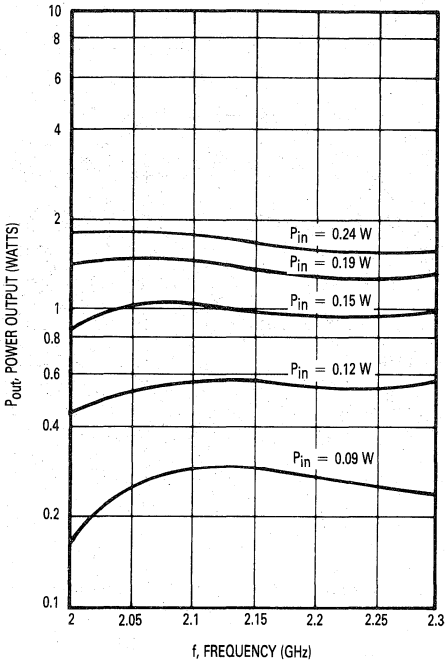


Figure 1. Power Output versus Frequency

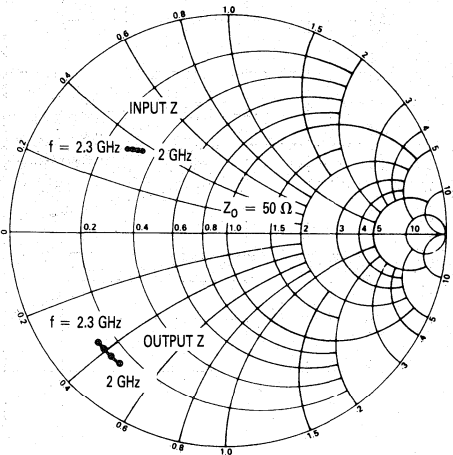


Figure 2. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

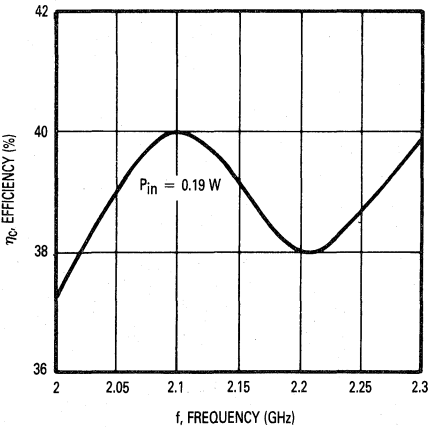


Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRAL2023-3

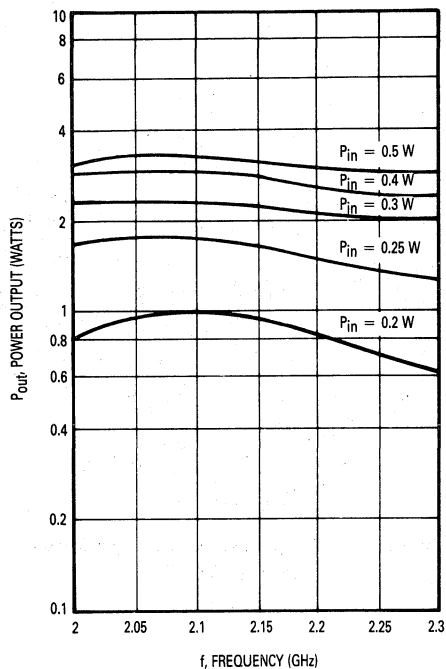


Figure 4. Power Output versus Frequency

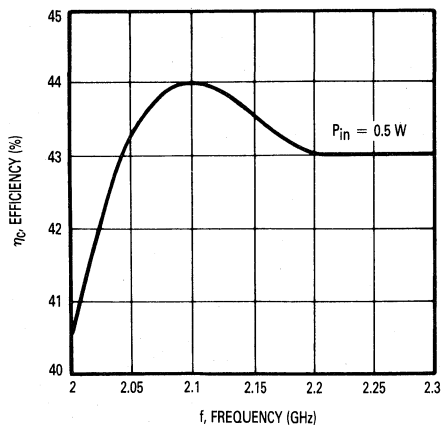


Figure 6. Efficiency versus Frequency

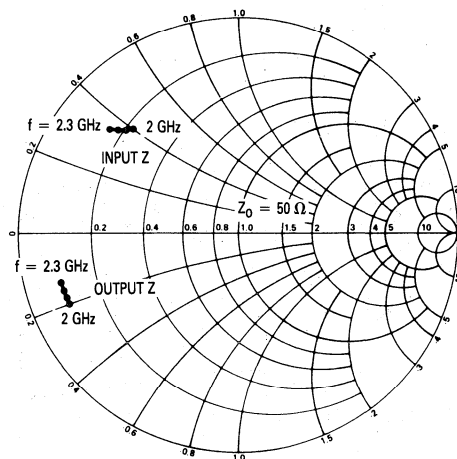


Figure 5. Series Equivalent Input/Output Impedance
 $V_{CC} = 22 \text{ V}$

TYPICAL CHARACTERISTICS
MRAL2023-6

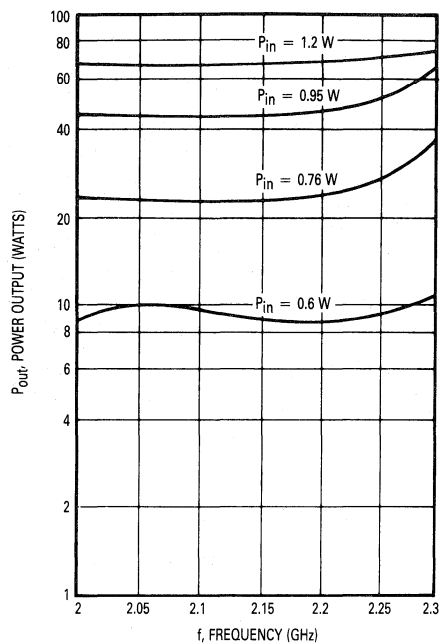


Figure 7. Power Output versus Frequency

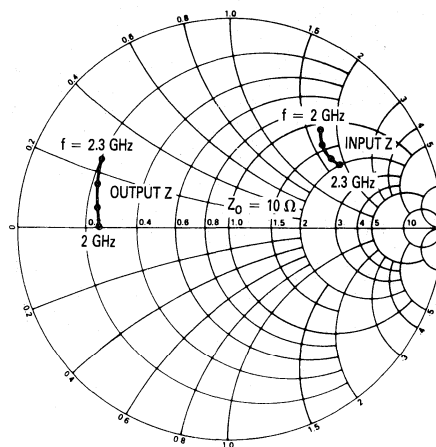


Figure 8. Series Equivalent Input/Output Impedance
 $V_{CC} = 22 \text{ V}$

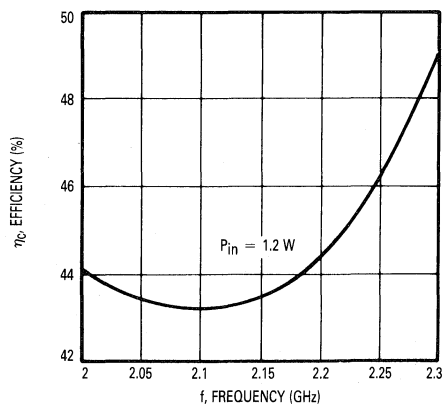


Figure 9. Efficiency versus Frequency

TYPICAL CHARACTERISTICS MRAL2023-12

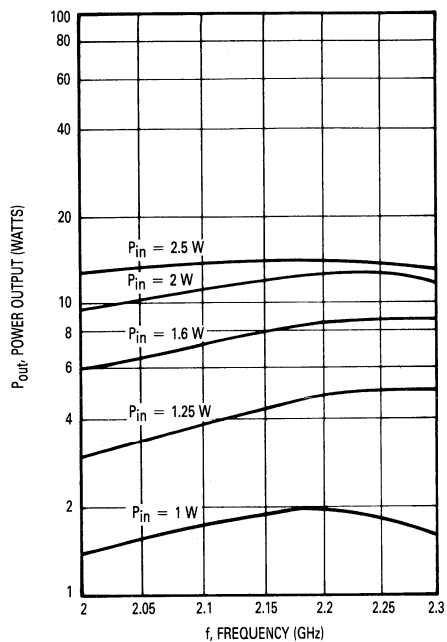


Figure 10. Power Output versus Frequency

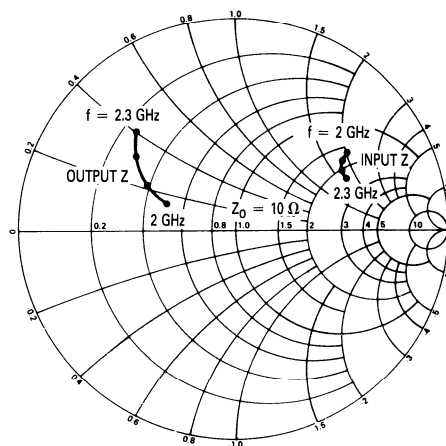
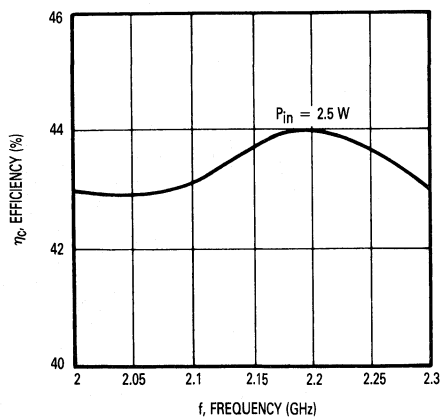
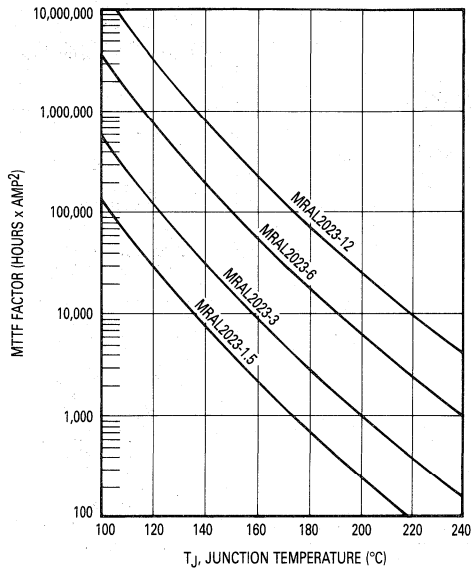
Figure 11. Series Equivalent Input/Output Impedance
 $V_{CC} = 22 \text{ V}$ 

Figure 12. Efficiency versus Frequency

MRAL2023 Series

The graph shown below displays MTTF in hours x ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



Example of MTTF for MRAL2023-12 Conditions

$$\begin{aligned}
 P_o &= 12 \text{ W} \\
 P_{in} &= 2.5 \text{ W} \\
 V_{CC} &= 22 \text{ V} \\
 \eta &= 40\% \\
 T_{FLANGE} &= 70^\circ\text{C} \\
 I_C = I_E &= \frac{100 \times P_o}{\eta \times V_{CC}} = 1.36 \text{ A} \\
 P_{DISS} &= P_{in} + V_{CC} \cdot I_C - P_o = 20.42 \text{ W} \\
 T_{JUNC} &= T_{FLANGE} + (\theta_{JF} \times P_{DISS}) = 161.89^\circ\text{C} \\
 \text{MTTF} &= \frac{2.05 \times 10^5 \text{ Hrs. Amp}^2}{I_C^2} = 110,834 \text{ Hrs} \\
 \text{MTTF} &= 12.65 \text{ Yrs}
 \end{aligned}$$

Figure 13. MTTF Factor versus Junction Temperature

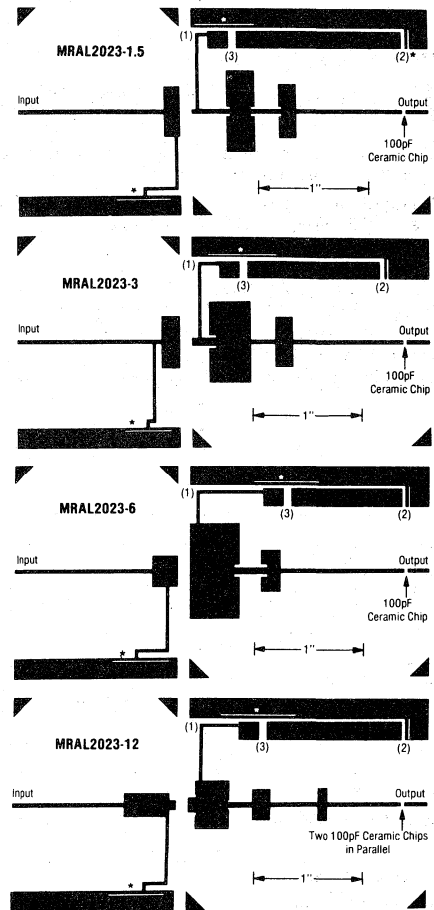


Figure 14. Test Circuit Boards (Not to Scale)

The RF Line

Microwave Power Transistors

2

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 2.3 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.3 GHz Characteristics:
 - Output Power — 18 Watts
 - Power Gain — 7 dB Min
 - Collector Efficiency — 35%, Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V _{CES}	42	V _{dc}
Emitter-Base Voltage	V _{EBO}	3.5	V _{dc}
Collector Current — Continuous	I _C	4	A _{dc}
Operating Junction Temperature	T _J	200	°C
Storage Temperature Range	T _{stg}	-65 to +150 -65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R _{θJC}	2.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (I _C = 160 mA, V _{BE} = 0)	V _{(BR)CES}	42	—	—	V _{dc}
Emitter-Base Breakdown Voltage (I _E = 2 mA, I _C = 0)	V _{(BR)EBO}	3.5	—	—	V _{dc}
Collector Cutoff Current (V _{CB} = 22 V, I _E = 0)	I _{CBO}	—	—	4	mA _{dc}

ON CHARACTERISTICS

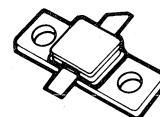
DC Current Gain (I _C = 800 mA, V _{CE} = 5 V)	h _{FE}	10	—	100	—
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FUNCTIONAL TESTS

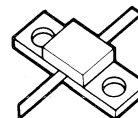
Common-Base Amplifier Power Gain (V _{CE} = 22 V, P _{out} = 18 W, f = 2.3 GHz)	G _{PB}	7	—	—	dB
Collector Efficiency (V _{CE} = 22 V, P _{out} = 18 W, f = 2.3 GHz)	η _c	35	—	—	%

MRAL2023-18
MRAL2023-18H

7 dB
2-2.3 GHz
18 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



HLP-11
CASE 393-01, STYLE 1
MRAL2023-18H



MRA .25
CASE 394-01, STYLE 1
MRAL2023-18

TYPICAL CHARACTERISTICS

The graph shown below displays MTTF in hours \times ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

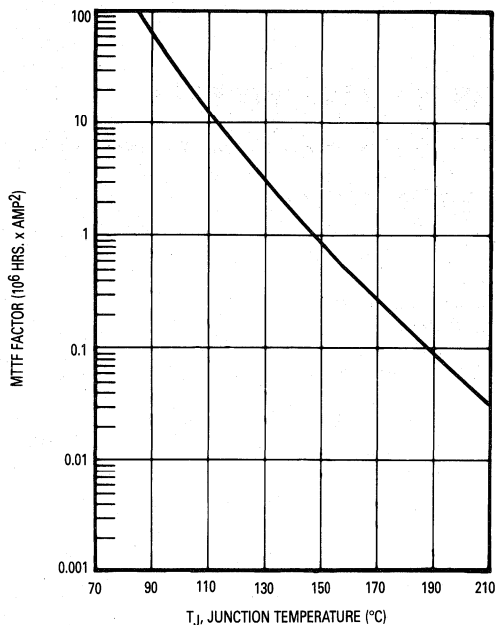


Figure 1. MTTF Factor versus Junction Temperature

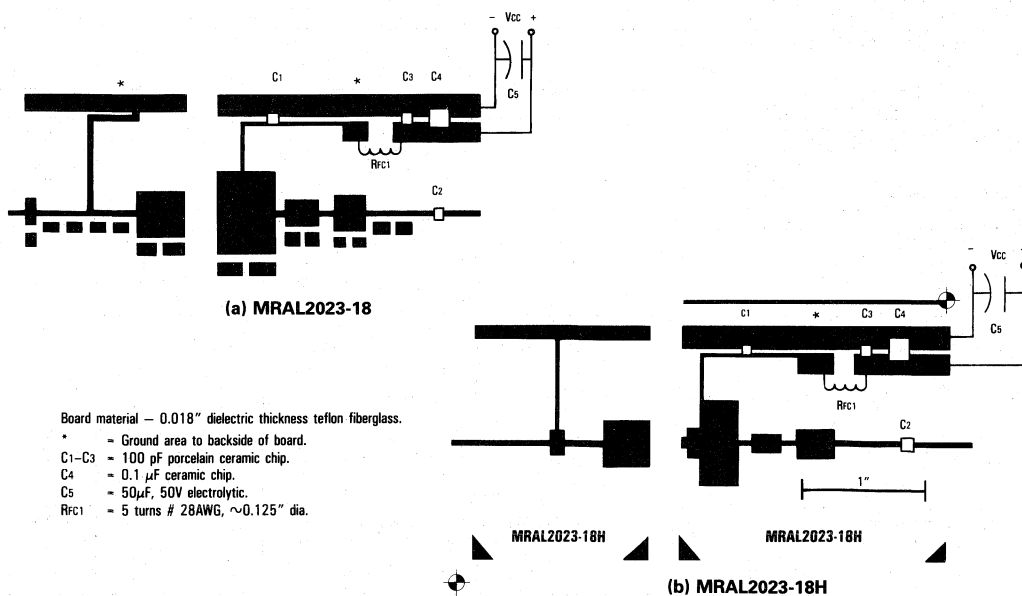


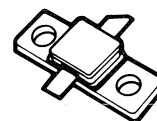
Figure 2. Test Circuit Boards (Not to Scale)

The RF Line

Microwave Power Transistors

MRAL2023H Series

6.8 to 8 dB
2–2.3 GHz
1.5 TO 12 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



HLP-11
CASE 393-01, STYLE 1

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 2.3 GHz frequency range.

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- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

MAXIMUM RATINGS

Rating	Symbol	-1.5H	-3H	-6H	-12H	Unit
Collector-Base Voltage	V_{CES}	42				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.25	0.5	1.25	2.5	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	-65 to +200				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	30	16	8	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $V_{BE} = 0$) ($I_C = 20$ mA, $V_{BE} = 0$) ($I_C = 50$ mA, $V_{BE} = 0$) ($I_C = 100$ mA, $V_{BE} = 0$)	MRAL2023-1.5H	$V_{(BR)CES}$	42	—	—	Vdc
	- 3H		42	—	—	
	- 6H		42	—	—	
	- 12H		42	—	—	
			42	—	—	
Emitter-Base Breakdown Voltage ($I_E = 0.2$ mA, $I_C = 0$) ($I_E = 0.4$ mA, $I_C = 0$) ($I_E = 1$ mA, $I_C = 0$) ($I_E = 2$ mA, $I_C = 0$)	MRAL2023-1.5H	$V_{(BR)EBO}$	3.5	—	—	Vdc
	- 3H		3.5	—	—	
	- 6H		3.5	—	—	
	- 12H		3.5	—	—	
			3.5	—	—	
Collector Cutoff Current ($V_{CB} = 22$ V, $I_E = 0$)	MRAL2023-1.5H	I_{CBO1}	—	—	0.25	mAdc
	- 3H		—	—	0.5	
	- 6H		—	—	1.25	
	- 12H		—	—	2.5	
			—	—	2.5	
Collector Cutoff Current ($V_{CE} = 38$ V, $I_E = 0$)	MRAL2023-1.5H	I_{CBO2}	—	—	0.5	mAdc
	- 3H		—	—	1	
	- 6H		—	—	2.5	
	- 12H		—	—	5	
			—	—	5	

(continued)

MRAL2023H Series

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain ($I_C = 0.1$ A, $V_{CE} = 5$ V) ($I_C = 0.2$ A, $V_{CE} = 5$ V) ($I_C = 0.5$ A, $V_{CE} = 5$ V) ($I_C = 1$ A, $V_{CE} = 5$ V)	MRAL2023-1.5H - 3H - 6H - 12H	h_{FE} 10 10 10 10	— — — —	90 90 90 90	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 22$ V, $I_E = 0$, $f = 1$ MHz)	MRAL2023-1.5H - 3H - 6H - 12H	C_{ob} — — — —	— — — —	3.5 5 10 (1) 20 (1)	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CE} = 22$ V, $P_{out} = 1.5$ W, $f = 2.3$ GHz) ($V_{CE} = 22$ V, $P_{out} = 3$ W, $f = 2.3$ GHz) ($V_{CE} = 22$ V, $P_{out} = 6$ W, $f = 2.3$ GHz) ($V_{CE} = 22$ V, $P_{out} = 12$ W, $f = 2.3$ GHz)	MRAL2023-1.5H - 3H - 6H - 12H	G_{PB} 8 8 6.8 6.8	— — — —	— — — —	dB
Collector Efficiency ($V_{CE} = 22$ V, $P_{out} = 1.5$ W, $f = 2.3$ GHz) ($V_{CE} = 22$ V, $P_{out} = 3$ W, $f = 2.3$ GHz) ($V_{CE} = 22$ V, $P_{out} = 6$ W, $f = 2.3$ GHz) ($V_{CE} = 22$ V, $P_{out} = 12$ W, $f = 2.3$ GHz)	MRAL2023-1.5H - 3H - 6H - 12H	η_c 35 40 40 40	— — — —	— — — —	%

Note 1. Nominal value — not measurable because of shunt inductor bypass.

TYPICAL CHARACTERISTICS MRAL2023-1.5H

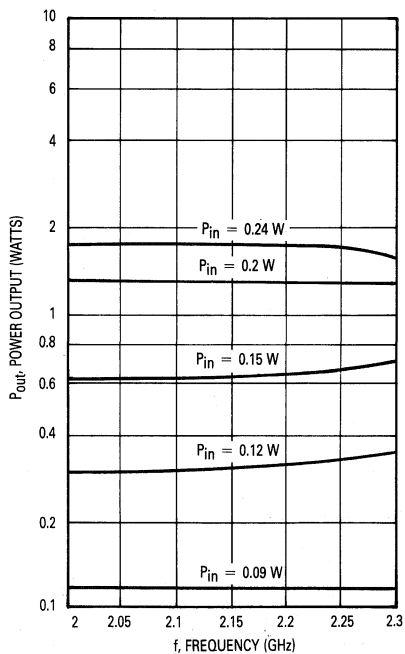


Figure 1. Power Output versus Frequency

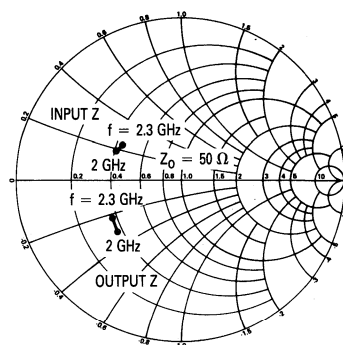


Figure 2. Series Equivalent Input/Output Impedance

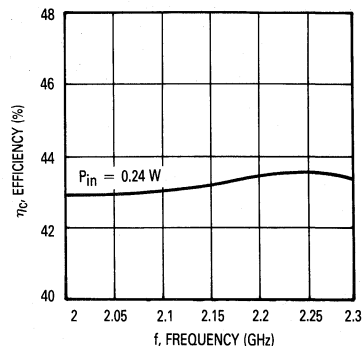


Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS
MRAL2023-3H

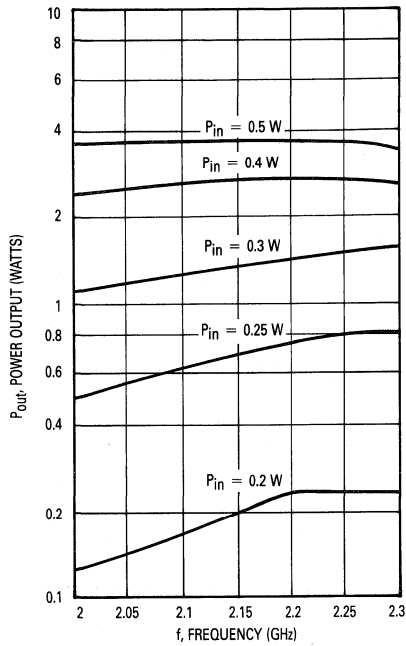


Figure 4. Power Output versus Frequency

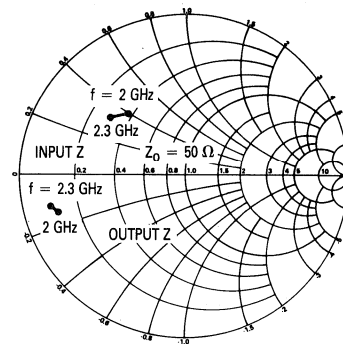


Figure 5. Series Equivalent Input/Output Impedance

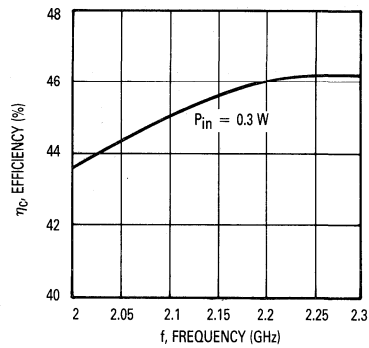


Figure 6. Efficiency versus Frequency

TYPICAL CHARACTERISTICS
MRAL2023-6H

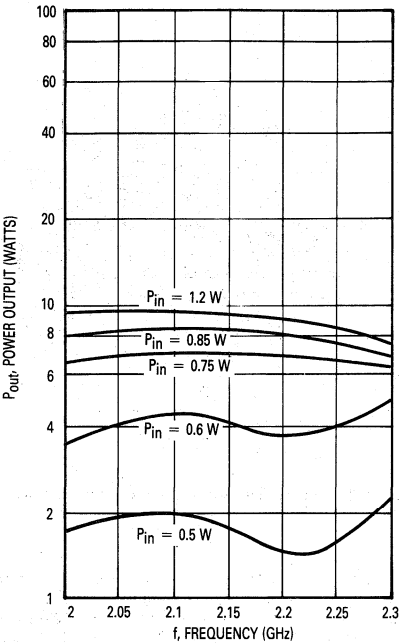


Figure 7. Power Output versus Frequency

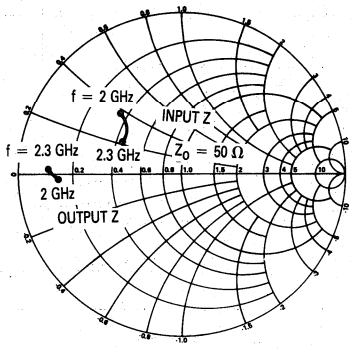


Figure 8. Series Equivalent Input/Output Impedance

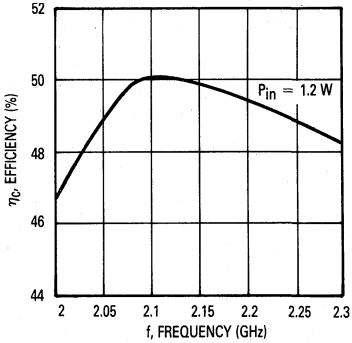


Figure 9. Efficiency versus Frequency

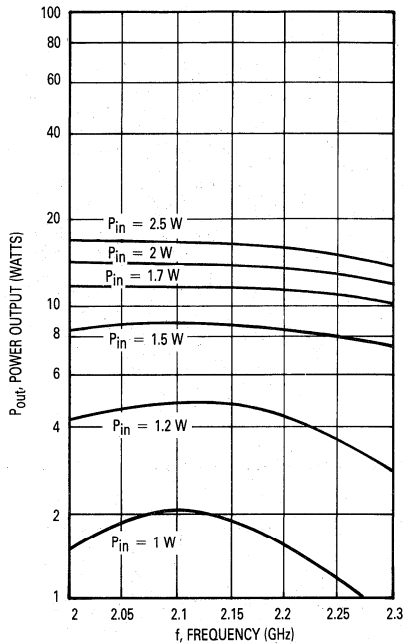
TYPICAL CHARACTERISTICS
MRAL2023-12H

Figure 10. Power Output versus Frequency

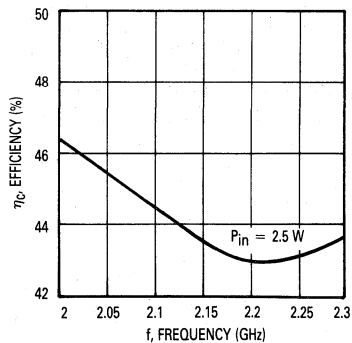


Figure 12. Efficiency versus Frequency

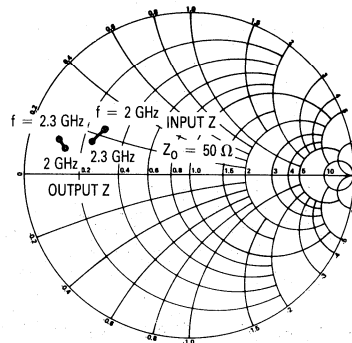


Figure 11. Series Equivalent Input/Output Impedance

The graph shown below displays MTTF in hours \times ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for actual MTTF in a particular application.

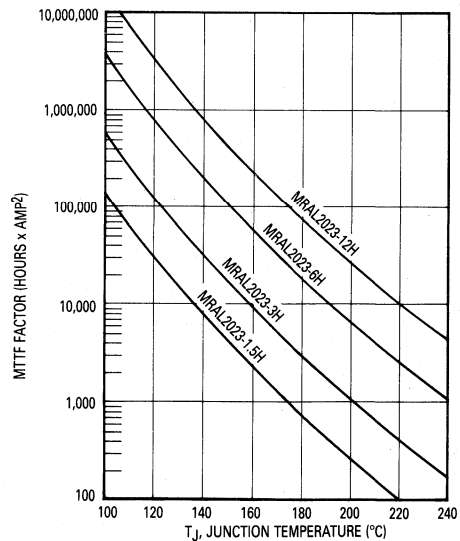


Figure 13. MTTF Factor versus Junction Temperature

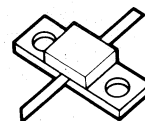
MRAL2327
Series

The RF Line
Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2.3 to 2.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.7 GHz Characteristics:
 - Output Power — 1.3 to 6 Watts
 - Power Gain — 5.5 to 7 dB Min, Common Base
 - Collector Efficiency — 30 to 35% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

5.5 to 7 dB
2.3-2.7 GHz
1.3 TO 6 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



MRA .25
CASE 394-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	-1.3	-3	-6	Unit
Collector-Base Voltage	V_{CES}		42		Vdc
Emitter-Base Voltage	V_{EBO}		3.5		Vdc
Operating Junction Temperature	T_J		200		°C
Storage Temperature Range	T_{stg}		-65 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	30	16	8	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $V_{BE} = 0$) ($I_C = 20$ mA, $V_{BE} = 0$) ($I_C = 50$ mA, $V_{BE} = 0$)	MRAL2327-1.3 -3 -6	$V_{(BR)CES}$	42 42 42	— — —	— — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.5$ mA, $I_E = 0$) ($I_C = 1$ mA, $I_E = 0$) ($I_C = 2.5$ mA, $I_E = 0$)	MRAL2327-1.3 -3 -6	$V_{(BR)CBO}$	38 38 38	— — —	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.2$ mA, $I_C = 0$) ($I_E = 0.4$ mA, $I_C = 0$) ($I_E = 1$ mA, $I_C = 0$)	MRAL2327-1.3 -3 -6	$V_{(BR)EBO}$	3.5 3.5 3.5	— — —	— — —	Vdc
Collector Cutoff Current ($V_{CB} = 22$ V, $I_E = 0$)	MRAL2327-1.3 -3 -6	I_{CBO}	— — —	— — —	0.25 0.5 1.25	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mA, $V_{CE} = 5$ V) ($I_C = 200$ mA, $V_{CE} = 5$ V) ($I_C = 500$ mA, $V_{CE} = 5$ V)	MRAL2327-1.3 -3 -6	h_{FE}	10 10 10	— — —	100 100 100	—
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CE} = 22\text{ V}$, $P_{out} = 1.3\text{ W}$, $f = 2.7\text{ GHz}$) ($V_{CE} = 22\text{ V}$, $P_{out} = 3\text{ W}$, $f = 2.7\text{ GHz}$) ($V_{CE} = 22\text{ V}$, $P_{out} = 6\text{ W}$, $f = 2.7\text{ GHz}$)	MRAL2327-1.3 -3 -6	G_{PB}	5.5 6.6 7	— — —	dB
Collector Efficiency ($V_{CE} = 22\text{ V}$, $P_{out} = 1.3\text{ W}$, $f = 2.7\text{ GHz}$) ($V_{CE} = 22\text{ V}$, $P_{out} = 3\text{ W}$, $f = 2.7\text{ GHz}$) ($V_{CE} = 22\text{ V}$, $P_{out} = 6\text{ W}$, $f = 2.7\text{ GHz}$)	MRAL2327-1.3 -3 -6	η_c	30 35 35	— — —	%

TYPICAL CHARACTERISTICS

MRAL2327-1.3

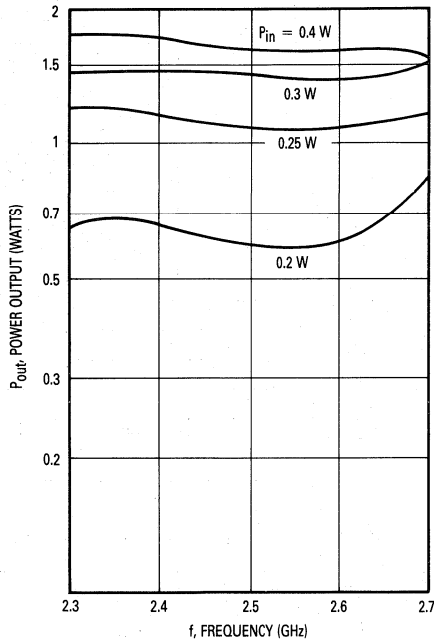


Figure 1. Power Output versus Frequency

MRAL2327-3

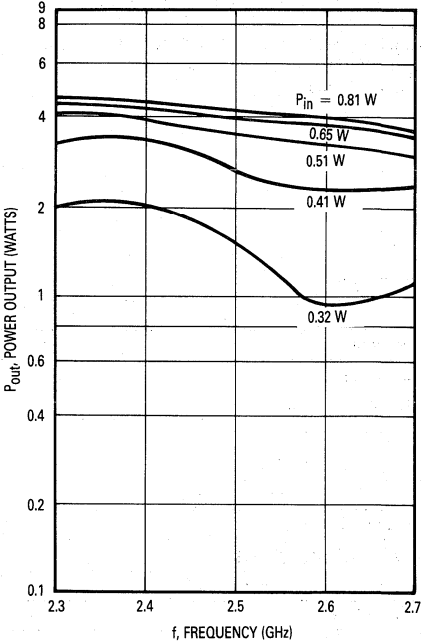


Figure 2. Power Output versus Frequency

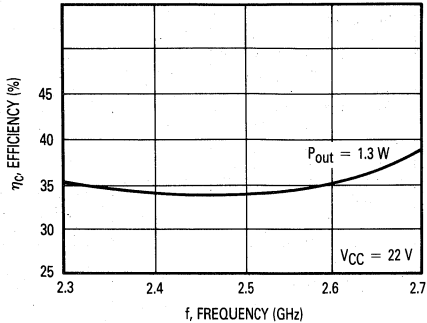


Figure 2. Collector Efficiency versus Frequency

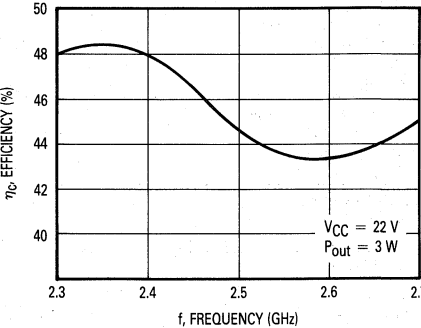


Figure 4. Collector Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRAL2327-6

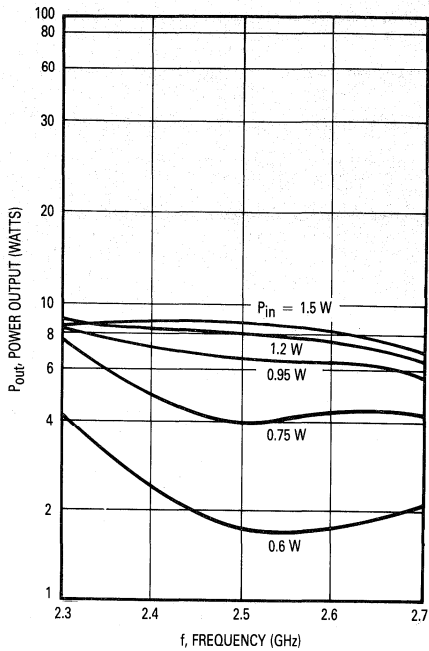


Figure 5. Power Output versus Frequency

MRAL2327-12

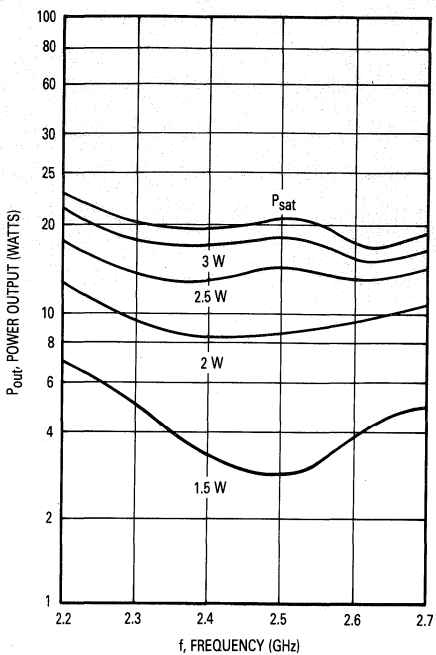


Figure 7. Power Output versus Frequency

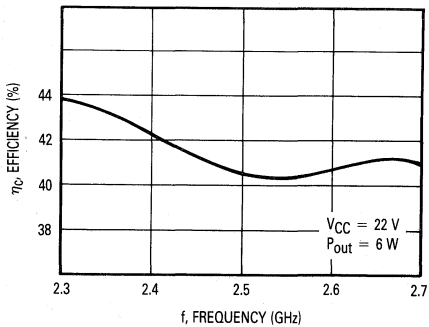


Figure 6. Collector Efficiency versus Frequency

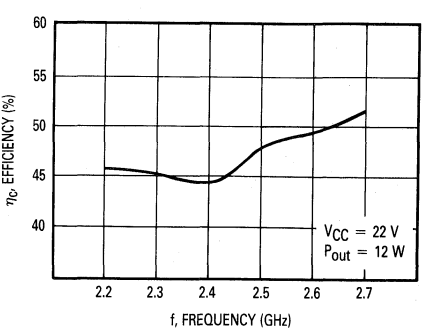


Figure 8. Collector Efficiency versus Frequency

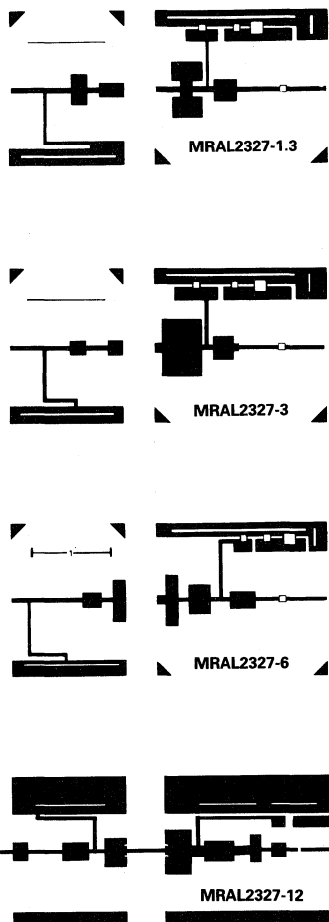


Figure 9. Circuit Boards
(Not to scale.)

Board material — 0.018" dielectric thickness Teflon fiberglass
 * Ground through to back side of board
 C1, C3 — 100 pF porcelain ceramic chip
 C4 — 0.1 μ F ceramic chip
 C5 — 50 μ F, 50 V electrolytic
 RFC1 — 5 turns #22 AWG, \sim 0.125 dia.

The graph shown below displays MTTF in hours \times ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular applications.

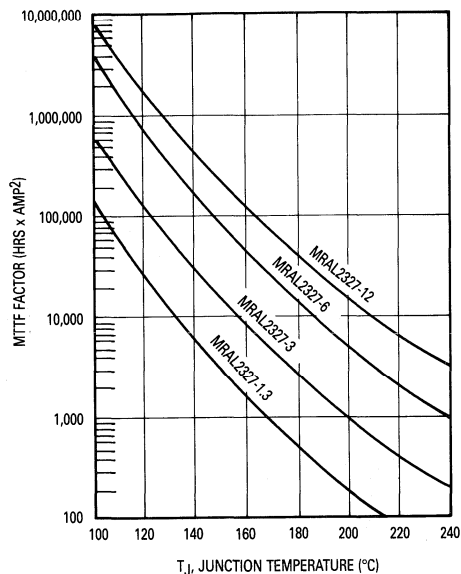


Figure 10. MTTF Factor versus Junction Temperature

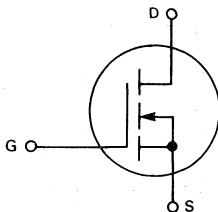
MRF134

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
 TMOS RF POWER FIELD-EFFECT TRANSISTOR**

... designed for wideband large-signal amplifier and oscillator applications in the 2.0 to 400 MHz range.

- Guaranteed 28 Volt, 150 MHz Performance
 - Output Power = 5.0 Watts
 - Minimum Gain = 11 dB
 - Efficiency — 55% (Typical)
- Small-Signal and Large-Signal Characterization
- Typical Performance at 400 MHz, 28 Vdc, 5.0 W
 - Output = 10.6 dB Gain
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 2.0 dB (Typ) at 200 mA, 150 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	65	Vdc
Drain — Gate Voltage ($R_{GS} = 1.0 \text{ M}\Omega$)	V_{DGR}	65	Vdc
Gate — Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	0.9	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	17.5 0.10	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

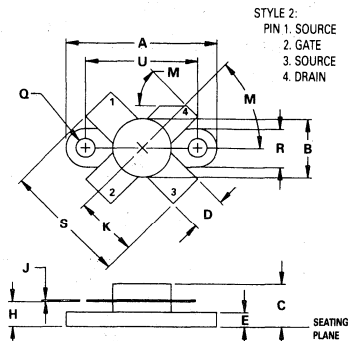
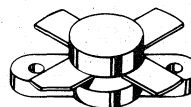
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	$^\circ\text{C}/\text{W}$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

5.0 W 2.0-400 MHz

**N-CHANNEL TMOS
 BROADBAND RF POWER
 FET**



NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 5.0$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	1.0	mA _{dc}
Gate-Source Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μA_{dc}

ON CHARACTERISTICS

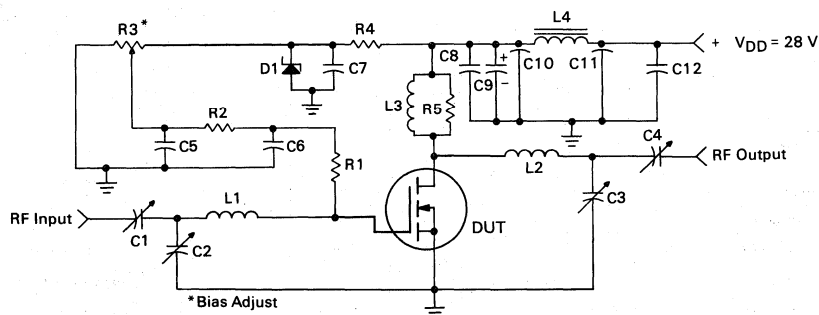
Gate Threshold Voltage ($I_D = 10$ mA, $V_{DS} = 10$ V)	$V_{GS(th)}$	1.0	3.5	6.0	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 100$ mA)	g_{fs}	80	110	—	mmhos

DYNAMIC CHARACTERISTICS

Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	7.0	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	9.7	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	2.3	—	pF

FUNCTIONAL CHARACTERISTICS

Noise Figure ($V_{DS} = 28$ Vdc, $I_D = 200$ mA, $f = 150$ MHz)	NF	—	2.0	—	dB
Common Source Power Gain ($V_{DD} = 28$ Vdc, $P_{out} = 5.0$ W, $I_{DQ} = 50$ mA) $f = 150$ MHz (Fig. 1) $f = 400$ MHz (Fig. 14)	G_{ps}	11	14 10.6	—	dB
Drain Efficiency (Fig. 1) ($V_{DD} = 28$ Vdc, $P_{out} = 5.0$ W, $f = 150$ MHz, $I_{DQ} = 50$ mA)	η	50	55	—	%
Electrical Ruggedness (Fig. 1) ($V_{DD} = 28$ Vdc, $P_{out} = 5.0$ W, $f = 150$ MHz, $I_{DQ} = 50$ mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 150 MHz TEST CIRCUIT

C1, C4 — Arco 406, 15–115 pF

C2 — Arco 403, 3–35 pF

C3 — Arco 402, 1.5–20 pF

C5, C6, C7, C8, C12 — 0.1 μF Erie RedcapC9 — 10 μF , 50 V

C10, C11 — 680 pF Feedthru

D1 — 1N5925A Motorola Zener

L1 — 3 Turns, 0.310" ID, #18 AWG Enamel, 0.2" Long

L2 — 3-1/2 Turns, 0.310" ID, #18 AWG Enamel, 0.25" Long

L3 — 20 Turns, #20 AWG Enamel Wound on R5

L4 — Ferroxcube VK-200 — 19/4B

R1 — 68 Ω , 1.0 W Thin FilmR2 — 10 k Ω , 1/4 WR3 — 10 Turns, 10 k Ω Beckman Instruments 8108R4 — 1.8 k Ω , 1/2 WR5 — 1.0 M Ω , 2.0 W Carbon

Board — G10, 62 mils

FIGURE 2 — OUTPUT POWER versus INPUT POWER

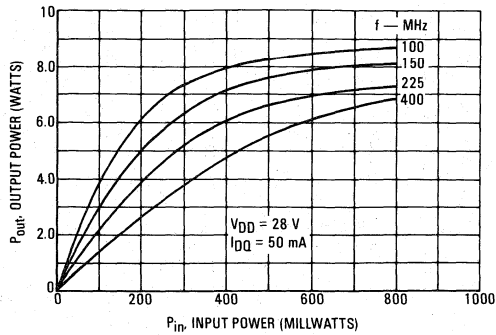


FIGURE 3 — OUTPUT POWER versus INPUT POWER

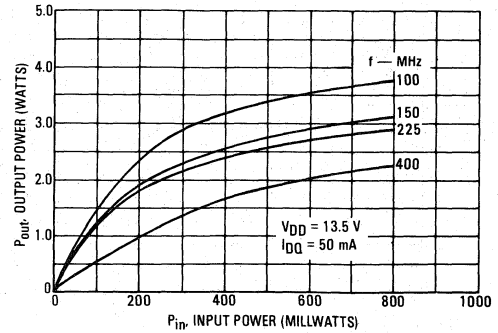
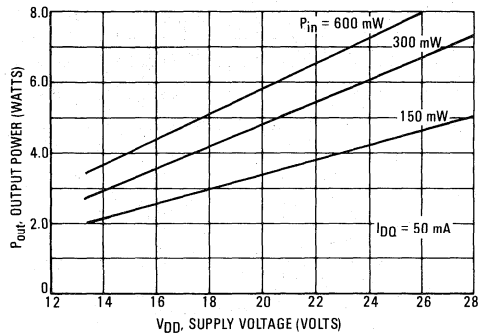
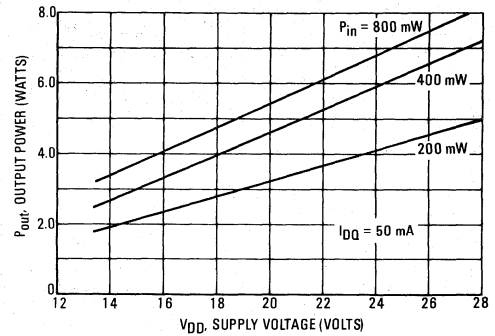
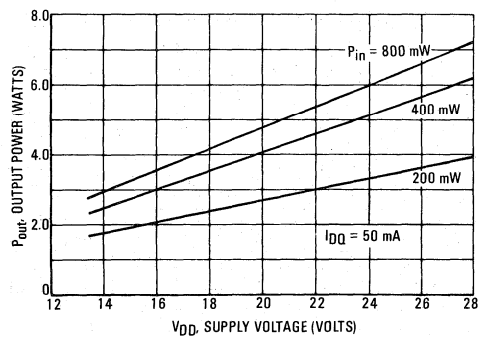
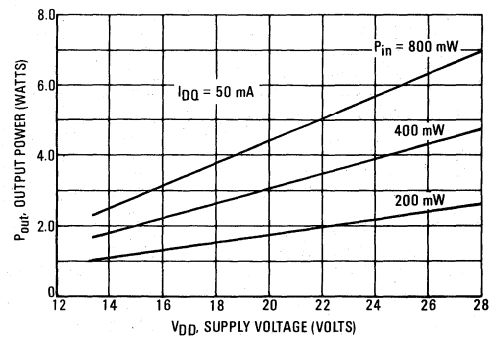
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 100\text{ MHz}$ FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 150\text{ MHz}$ FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 225\text{ MHz}$ FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 400\text{ MHz}$ 

FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

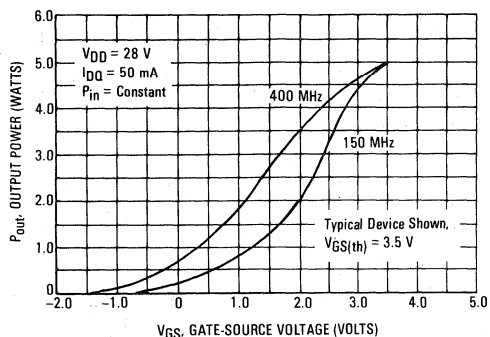


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

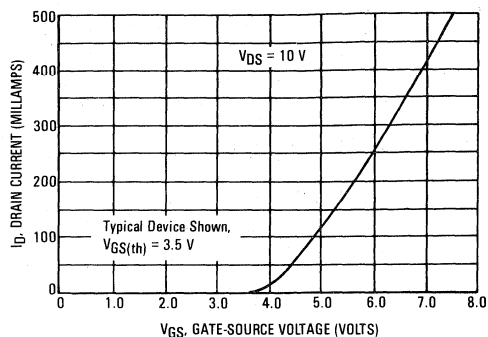


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

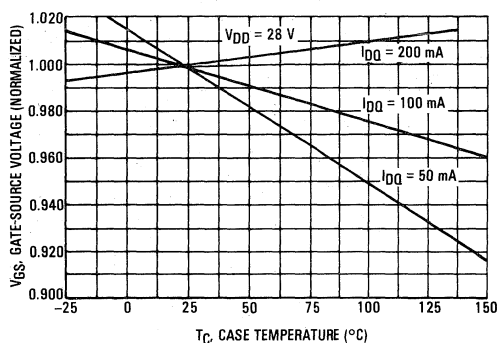


FIGURE 11 — MAXIMUM AVAILABLE GAIN versus FREQUENCY

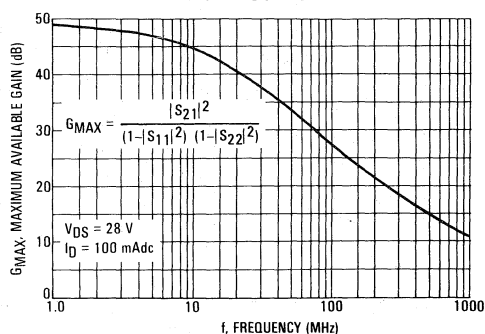


FIGURE 12 — CAPACITANCE versus VOLTAGE

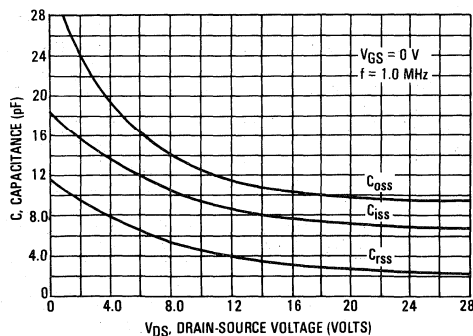


FIGURE 13 — MAXIMUM RATED FORWARD BIASED SAFE OPERATING AREA

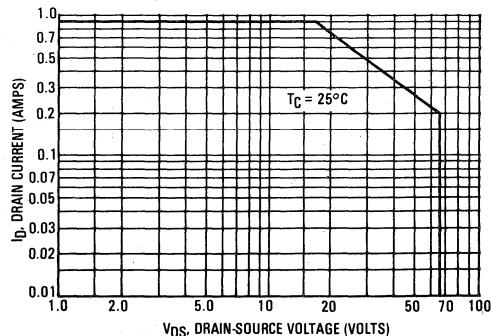
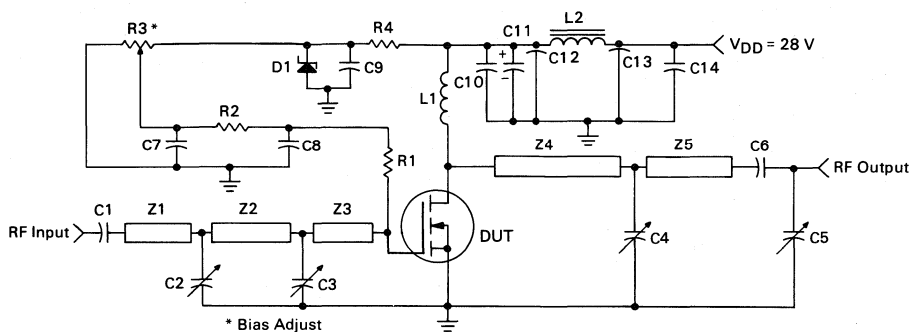


FIGURE 14 — 400 MHz TEST CIRCUIT



C1, C6 — 270 pF, ATC 100 mils
 C2, C3, C4, C5 — 0–20 pF Johanson
 C7, C9, C10, C14 — 0.1 μ F Erie Redcap, 50 V
 C8 — 0.001 μ F
 C11 — 10 μ F, 50 V
 C12, C13 — 680 pF Feedthru
 D1 — 1N5925A Motorola Zener
 L1 — 6 Turns, 1/4" ID, #20 AWG Enamel
 L2 — Ferroxcube VK-200 — 19/4B
 R1 — 68 Ω , 1.0 W Thin Film

R2 — 10 k Ω , 1/4 W
 R3 — 10 Turns, 10 k Ω Beckman Instruments 8108
 R4 — 1.8 k Ω , 1/2 W
 Z1 — 1.4" \times 0.166" Microstrip
 Z2 — 1.1" \times 0.166" Microstrip
 Z3 — 0.95" \times 0.166" Microstrip
 Z4 — 2.2" \times 0.166" Microstrip
 Z5 — 0.85" \times 0.166" Microstrip
 Board — Glass Teflon, 62 mils

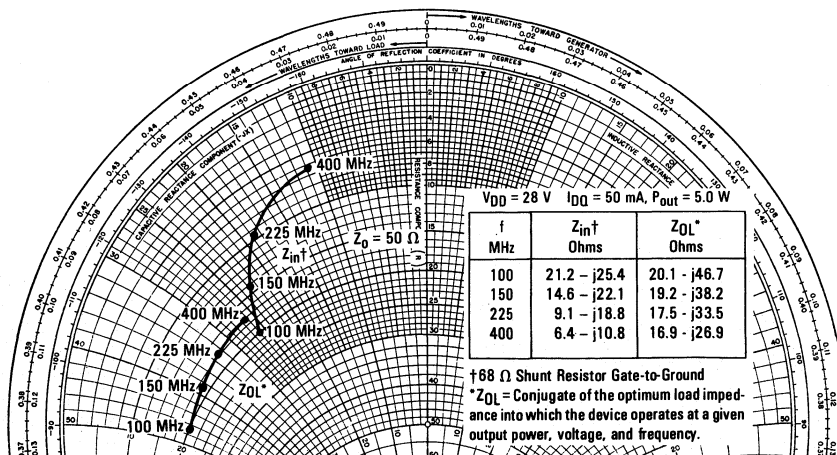
FIGURE 15 — LARGE-SIGNAL SERIES EQUIVALENT
INPUT/OUTPUT IMPEDANCES, Z_{in}^{\dagger} , Z_{OL}^* 

FIGURE 16 — COMMON SOURCE SCATTERING PARAMETERS
 $V_{DS} = 28 \text{ V}$, $I_D = 100 \text{ mA}$

f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
1.0	0.989	-1.0	11.27	179	0.0014	89	0.954	-1.0
2.0	0.989	-2.0	11.27	179	0.0028	89	0.954	-2.0
5.0	0.988	-5.0	11.26	176	0.0069	86	0.954	-4.0
10	0.985	-10	11.20	173	0.014	83	0.951	-9.0
20	0.977	-20	10.99	166	0.027	76	0.938	-18
30	0.965	-30	10.66	159	0.039	69	0.918	-26
40	0.950	-39	10.25	153	0.051	63	0.895	-34
50	0.931	-47	9.777	147	0.060	57	0.867	-42
60	0.912	-53	9.359	142	0.069	53	0.846	-49
70	0.892	-58	8.960	138	0.077	49	0.828	-56
80	0.874	-62	8.583	135	0.085	46	0.815	-62
90	0.855	-66	8.190	131	0.091	43	0.801	-68
100	0.833	-70	7.808	128	0.096	40	0.785	-74
110	0.827	-73	7.661	125	0.101	38	0.784	-77
120	0.821	-76	7.515	122	0.107	36	0.784	-82
130	0.814	-79	7.368	119	0.113	34	0.784	-85
140	0.808	-82	7.222	116	0.119	32	0.783	-88
150	0.802	-86	7.075	114	0.125	31	0.783	-90
160	0.788	-89	6.810	112	0.127	30	0.780	-92
170	0.774	-92	6.540	110	0.128	28	0.774	-94
180	0.763	-94	6.220	108	0.130	26	0.762	-98
190	0.751	-97	5.903	106	0.132	24	0.760	-100
200	0.740	-100	5.784	104	0.134	23	0.758	-103
225	0.719	-104	5.334	100	0.136	20	0.757	-107
250	0.704	-108	4.904	97	0.139	19	0.758	-110
275	0.687	-113	4.551	92	0.141	16	0.757	-114
300	0.673	-117	4.219	89	0.141	14	0.750	-117
325	0.668	-120	3.978	86	0.142	12	0.757	-120
350	0.669	-123	3.737	83	0.142	10	0.766	-121
375	0.662	-125	3.519	80	0.143	9.0	0.768	-123
400	0.654	-127	3.325	77	0.142	8.0	0.772	-124
425	0.650	-129	3.170	75	0.140	7.0	0.772	-125
450	0.638	-131	3.048	72	0.141	6.0	0.783	-125
475	0.614	-132	2.898	71	0.136	6.0	0.786	-126
500	0.641	-133	2.833	68	0.136	5.0	0.795	-127
525	0.638	-135	2.709	66	0.135	5.0	0.801	-127
550	0.633	-137	2.574	64	0.133	4.0	0.802	-128
575	0.628	-138	2.481	62	0.131	5.0	0.805	-128
600	0.625	-140	2.408	60	0.129	5.0	0.814	-128
625	0.619	-142	2.334	58	0.128	5.0	0.818	-129
650	0.617	-144	2.259	56	0.125	6.0	0.824	-130
675	0.618	-146	2.192	55	0.123	7.0	0.834	-130
700	0.619	-147	2.124	53	0.122	8.0	0.851	-131
725	0.618	-150	2.061	51	0.120	9.0	0.859	-132
750	0.614	-152	1.983	49	0.118	11	0.857	-133
775	0.609	-154	1.908	48	0.119	13	0.865	-133
800	0.562	-155	1.877	49	0.118	15	0.872	-133
825	0.587	-156	1.869	46	0.119	16	0.869	-134
850	0.593	-158	1.794	44	0.118	18	0.875	-135
875	0.597	-160	1.749	43	0.119	18	0.881	-135
900	0.598	-162	1.700	41	0.118	18	0.889	-136
925	0.592	-164	1.641	40	0.115	18	0.888	-138
950	0.588	-166	1.590	39	0.112	20	0.877	-138
975	0.586	-168	1.572	39	0.108	23	0.864	-137
1000	0.590	-171	1.551	37	0.107	28	0.863	-137

The Power RF characterization data were measured with a 68 ohm resistor shunting the MRF134 input port. The scattering parameters were measured on the MRF134 device alone with no external components.

FIGURE 17 — S_{11} , INPUT REFLECTION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$ $I_D = 100 \text{ mA}$

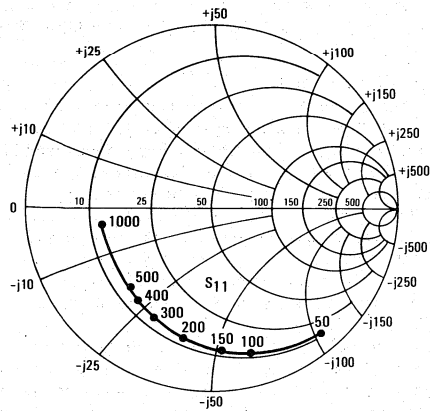


FIGURE 18 — S_{12} , REVERSE TRANSMISSION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$ $I_D = 100 \text{ mA}$

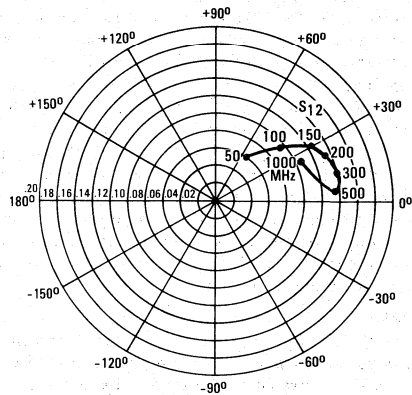


FIGURE 19 — S_{21} , FORWARD TRANSMISSION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$ $I_D = 100 \text{ mA}$

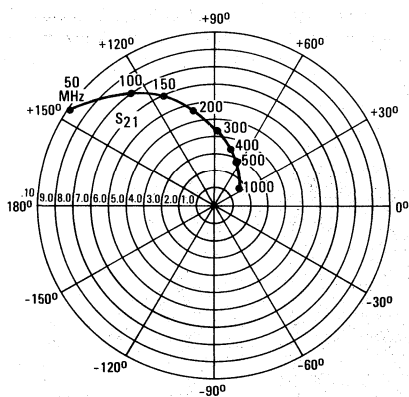
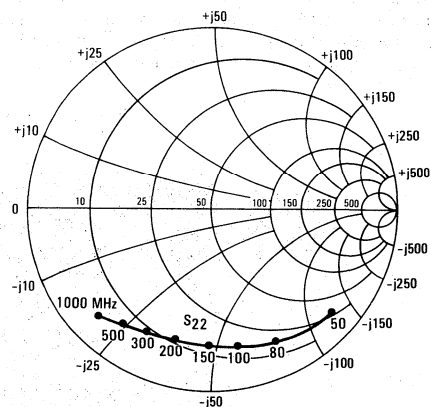


FIGURE 20 — S_{22} , OUTPUT REFLECTION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$ $I_D = 100 \text{ mA}$



DESIGN CONSIDERATIONS

The MRF134 is a TMOS RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for VHF power amplifier and oscillator applications. Motorola TMOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of TMOS RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF134 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF134 was characterized at $I_{DQ} = 50$ mA, which is the suggested minimum value of I_{DQ} . For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF134 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC, and modulation systems. (See Figure 8.)

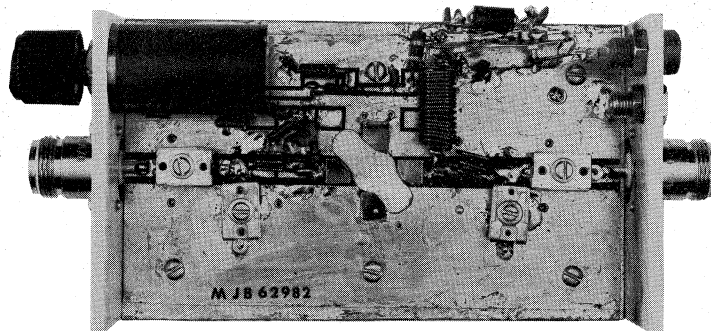
AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF134. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of TMOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of TMOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF134, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. The MRF134 was characterized with a 68-ohm input shunt loading resistor. Two port parameter stability analysis with the MRF134 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two port network theory and stability.

Input resistive loading is not feasible in low noise applications. The MRF134 noise figure data was generated in a circuit with drain loading and a low loss input network.

FIGURE 21 — 150 MHz TEST CIRCUIT



The RF TMOS Line

RF Power Field-Effect Transistors
N-Channel Enhancement-Mode TMOS

... designed for wideband large-signal amplifier and oscillator applications in the 2 to 400 MHz range, in either single ended or push-pull configuration.

- Guaranteed 28 Volt, 150 MHz Performance

MRF136

Output Power = 15 Watts
 Narrowband Gain = 16 dB (Typ)
 Efficiency = 60% (Typical)

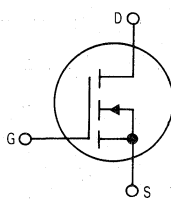
- Small-Signal and Large-Signal Characterization
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Space Saving Package For Push-Pull Circuit Applications — MRF136Y
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques

MRF136Y

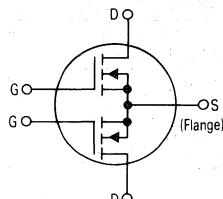
Output Power = 30 Watts
 Broadband Gain = 14 dB (Typ)
 Efficiency = 54% (Typical)



MRF136

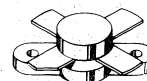


MRF136Y

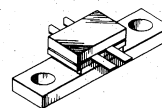


MRF136
MRF136Y

15 W, 30 W 2–400 MHz
N-CHANNEL
TMOS BROADBAND
RF POWER FETs



MRF136
CASE 211-07



MRF136Y
CASE 319B-01

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
		MRF136	MRF136Y	
Drain-Source Voltage	V_{DSS}	65	65	Vdc
Drain-Gate Voltage ($R_{GS} = 1 \text{ M}\Omega$)	V_{DGR}	65	65	Vdc
Gate-Source Voltage	V_{GS}	± 40		Vdc
Drain-Current — Continuous	I_D	2.5	5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	55 0.314	100 0.571	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150		°C
Operating Junction Temperature	T_J	200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max		Unit
		MRF136	MRF136Y	
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.2	1.75	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (NOTE 1)

Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 5$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero-Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	2	mAdc
Gate-Source Leakage Current ($V_{GS} = 40$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1	μAdc

ON CHARACTERISTICS (NOTE 1)

Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 25$ mA)	$V_{GS(th)}$	1	3	6	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 250$ mA)	g_{fs}	250	400	—	mmhos

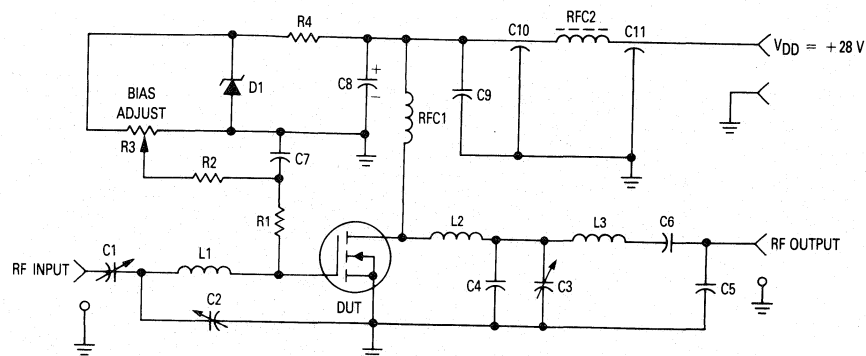
DYNAMIC CHARACTERISTICS (NOTE 1)

Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1$ MHz)	C_{iss}	—	24	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1$ MHz)	C_{oss}	—	27	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1$ MHz)	C_{rss}	—	5.5	—	pF

FUNCTIONAL CHARACTERISTICS (NOTE 2)

Noise Figure ($V_{DS} = 28$ Vdc, $I_D = 500$ mA, $f = 150$ MHz)	MRF136	NF	—	1	—	dB
Common Source Power Gain (Figure 1) ($V_{DD} = 28$ Vdc, $P_{out} = 15$ W, $f = 150$ MHz, $I_{DQ} = 25$ mA)	MRF136	G_{ps}	13	16	—	dB
Common Source Power Gain (Figure 2) ($V_{DD} = 28$ Vdc, $P_{out} = 30$ W, $f = 150$ MHz, $I_{DQ} = 100$ mA)	MRF136Y	G_{ps}	12	14	—	dB
Drain Efficiency (Figure 1) ($V_{DD} = 28$ Vdc, $P_{out} = 15$ W, $f = 150$ MHz, $I_{DQ} = 25$ mA)	MRF136	η	50	60	—	%
Drain Efficiency (Figure 2) ($V_{DD} = 28$ Vdc, $P_{out} = 30$ W, $f = 150$ MHz, $I_{DQ} = 100$ mA)	MRF136Y	η	50	54	—	%
Electrical Ruggedness (Figure 1) ($V_{DD} = 28$ Vdc, $P_{out} = 15$ W, $f = 150$ MHz, $I_{DQ} = 25$ mA, VSWR 30:1 at all Phase Angles)	MRF136	ψ	No Degradation in Output Power			
Electrical Ruggedness (Figure 2) ($V_{DD} = 28$ Vdc, $P_{out} = 30$ W, $f = 150$ MHz, $I_{DQ} = 100$ mA, VSWR 30:1 at all Phase Angles)	MRF136Y	ψ	No Degradation in Output Power			

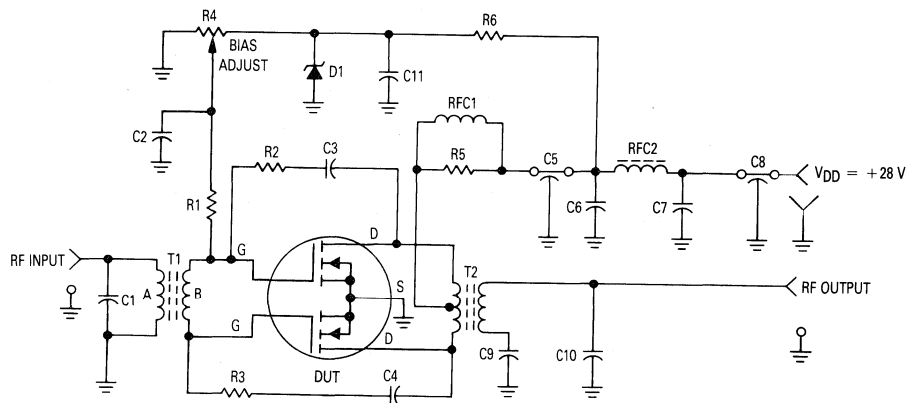
Notes: 1. For MRF136Y, each side measured separately.
2. For MRF136Y measured in push-pull configuration.



C1, C2 — Arco 406, 15–115 pF or Equivalent
 C3 — Arco 404, 8–60 pF or Equivalent
 C4 — 43 pF Mini-Unelco or Equivalent
 C5 — 24 pF Mini-Unelco or Equivalent
 C6 — 680 pF, 100 Mills Chip
 C7 — 0.01 μ F Ceramic
 C8 — 100 μ F, 40 V
 C9 — 0.1 μ F Ceramic
 C10, C11 — 680 pF Feedthru
 D1 — 1N5925A Motorola Zener

L1 — 2 Turns, 0.29" ID, #18 AWG, 0.10" Long
 L2 — 2 Turns, 0.23" ID, #18 AWG, 0.10" Long
 L3 — 2-1/4 Turns, 0.29" ID, #18 AWG, 0.125" Long
 RFC1 — 20 Turns, 0.30" ID, #20 AWG Enamel Closewound
 RFC2 — Ferroxcube VK-200 — 19/4B
 R1 — 27 Ω , 1 W Thin Film
 R2 — 10 k Ω , 1/4 W
 R3 — 10 Turns, 10 k Ω
 R4 — 1.8 k Ω , 1/2 W
 Board Material — 0.062" G10, 1 oz. Cu Clad, Double Sided

Figure 1. 150 MHz Test Circuit (MRF136)



C1 — 5 pF
 C2, C3, C4, C6, C7, C9, C11 — 0.1 μ F Ceramic
 C5, C8 — 680 pF Feedthru
 C10 — 15 pF
 D1 — 1N4740 Motorola Zener
 RFC1 — 17 Turns, #24 AWG Wound on R5
 RFC2 — Ferroxcube VK-200-19/4B or Equivalent
 R1 — 10 k Ω , 1/4 W
 R2, R3 — 560 Ω , 1/2 W
 R4 — 10 Turns, 10 k Ω

R5 — 56 k Ω , 1 W
 R6 — 1.6 k Ω , 1/4 W
 T1 — Primary Winding — 3 Turns #28 Enameled Wire.
 — Secondary Winding — 2 Turns #28 Enameled Wire.
 Both windings wound through a Fair/Rite Balun 65 core.
 Part #2865002402.
 T2 — 1:1 Transformer Wound Bifilar — 2 Turns Twisted Pair
 #24 Enameled Wire through a Indiana General Balun Q1
 core. Part #18006-1-Q1. Primary winding center tapped.
 Board Material — 0.062" G10, 1 oz. Cu Clad, Double Sided

Figure 2. 30–150 MHz Test Circuit (MRF136Y)

MRF136

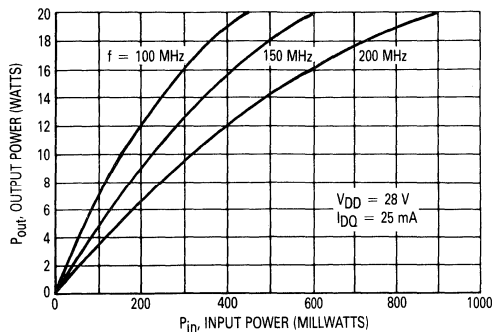


Figure 3. Output Power versus Input Power

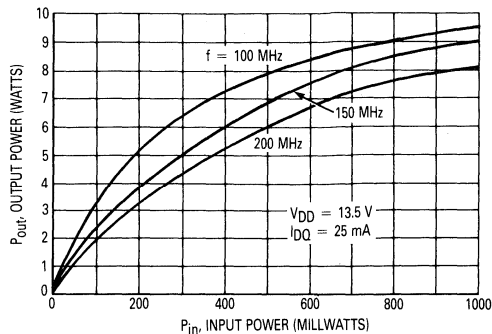


Figure 4. Output Power versus Input Power

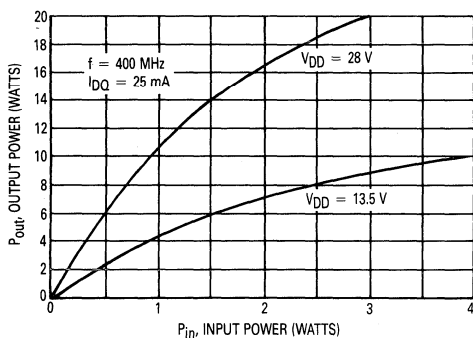
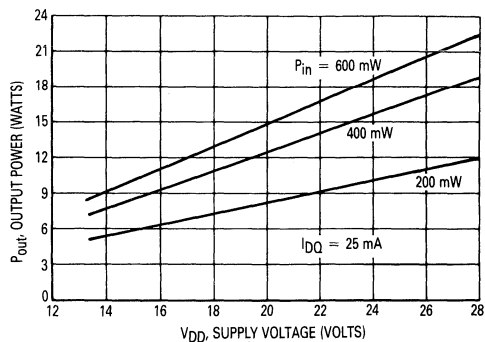
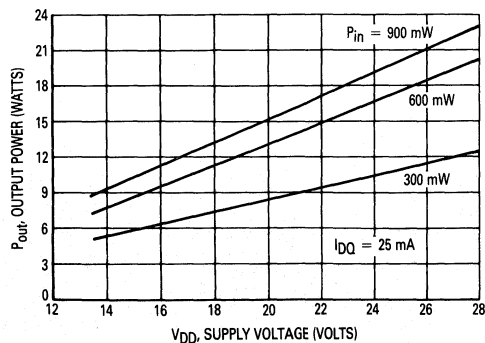
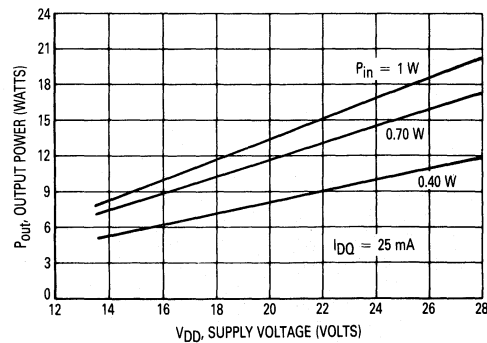


Figure 5. Output Power versus Input Power

Figure 6. Output Power versus Supply Voltage
f = 100 MHzFigure 7. Output Power versus Supply Voltage
f = 150 MHzFigure 8. Output Power versus Supply Voltage
f = 200 MHz

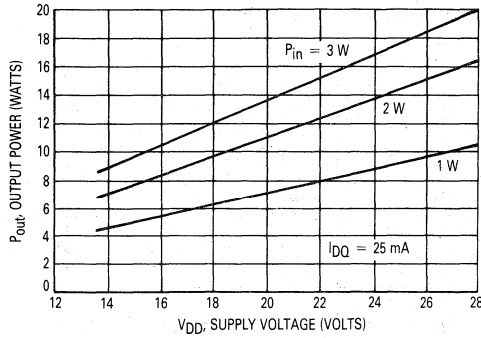


Figure 9. Output Power versus Supply Voltage
f = 400 MHz
MRF136

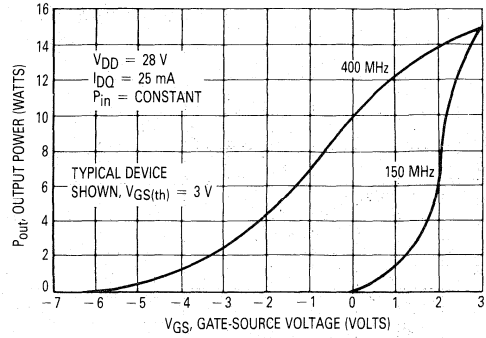


Figure 10. Output Power versus Gate Voltage
MRF136

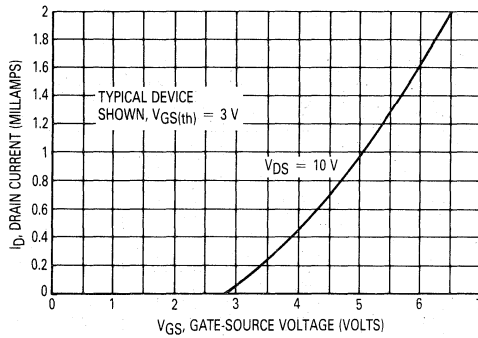


Figure 11. Drain Current versus Gate Voltage
(Transfer Characteristics)*
MRF136/MRF136Y

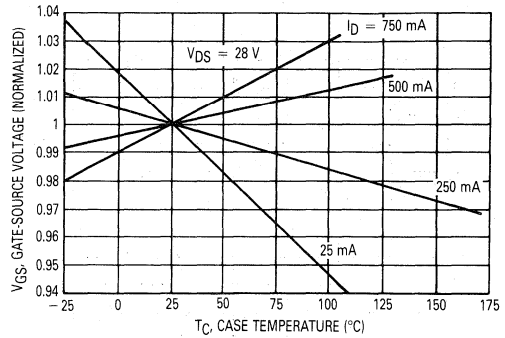


Figure 12. Gate-Source Voltage versus
Case Temperature*
MRF136/MRF136Y

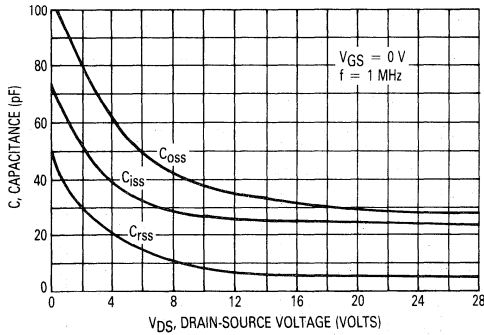


Figure 13. Capacitance versus Drain-Source Voltage*
MRF136/MRF136Y

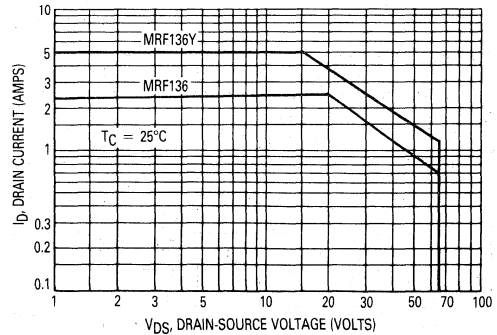


Figure 14. DC Safe Operating Area
MRF136/MRF136Y

*Data shown applies to MRF136 and each half of MRF136Y.

MRF136Y

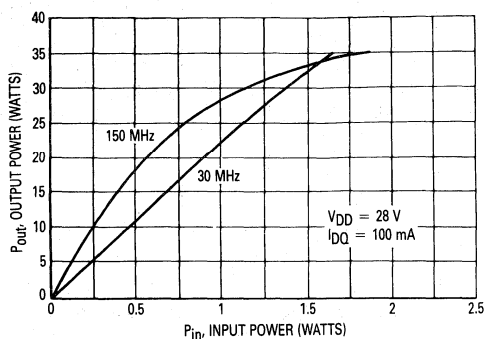
TYPICAL PERFORMANCE IN BROADBAND TEST CIRCUIT
(Refer to Figure 2)

Figure 15. Output Power versus Input Power

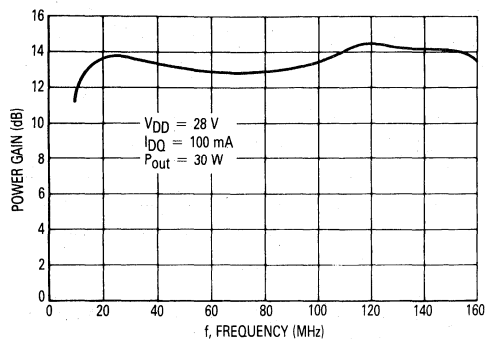


Figure 16. Power Gain versus Frequency

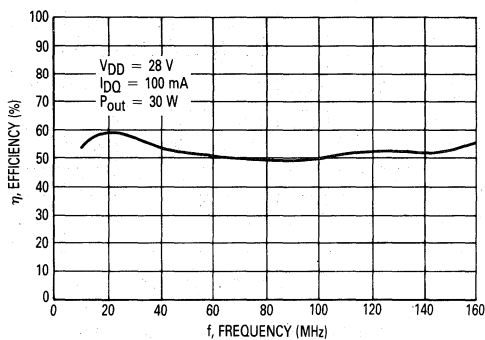


Figure 17. Drain Efficiency versus Frequency

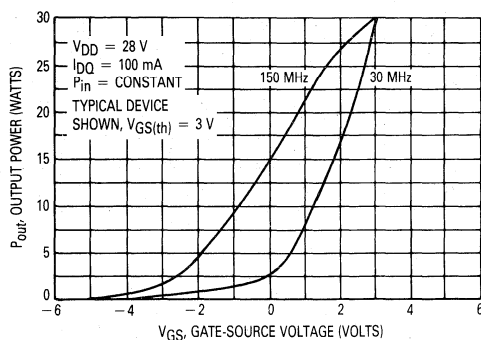
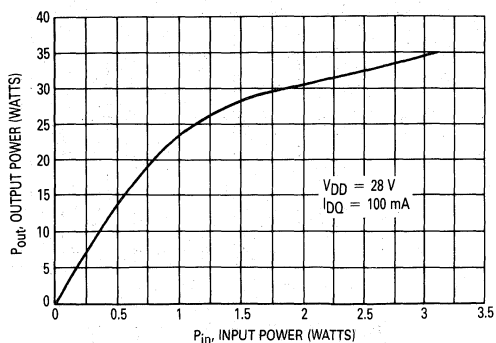
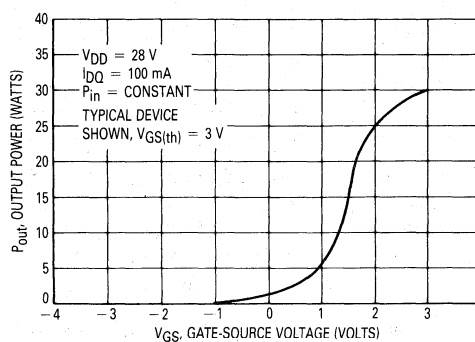


Figure 18. Output Power versus Gate Voltage

TYPICAL 400 MHz PERFORMANCE

Figure 19. Output Power versus Input Power
 $f = 400 \text{ MHz}$ Figure 20. Output Power versus Gate Voltage
 $f = 400 \text{ MHz}$

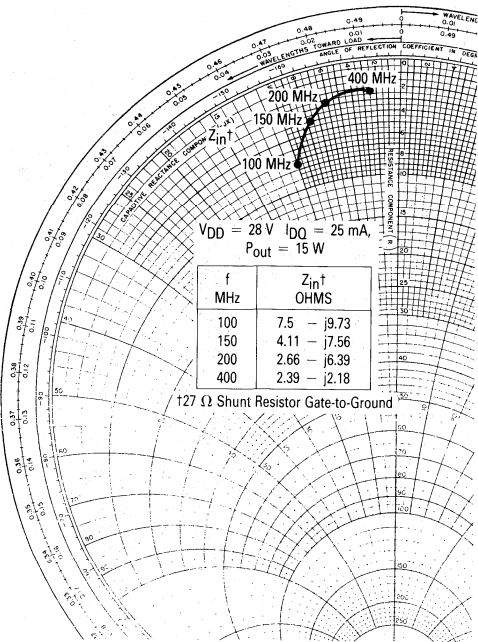


Figure 21. Large-Signal Series Equivalent Input Impedance, Z_{in}^{\dagger}
MRF136

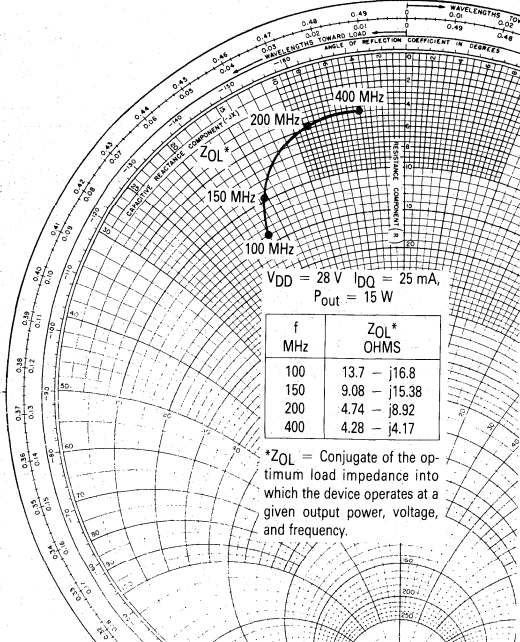


Figure 22. Large-Signal Series Equivalent Output Impedance, Z_{OL}^*
MRF136

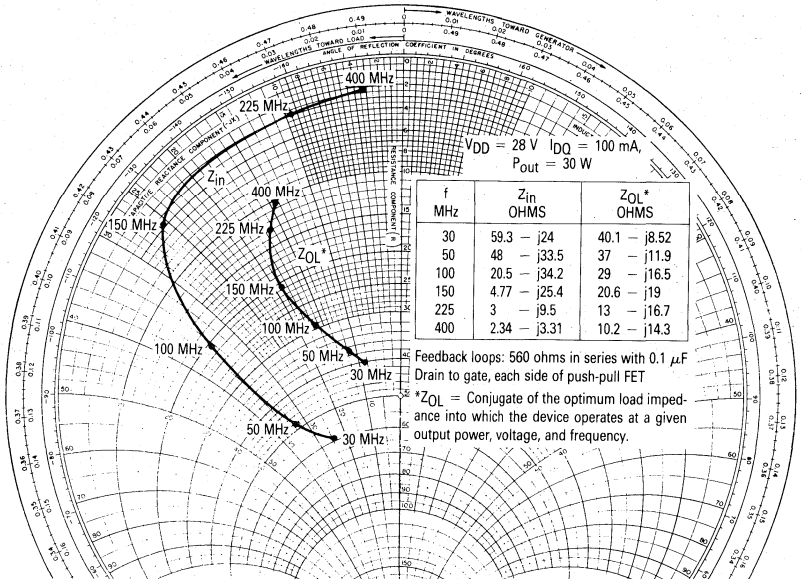


Figure 23. Input and Output Impedance
MRF136Y

MRF136

f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
2.0	0.988	-11	41.19	173	0.006	67	0.729	-12
5.0	0.970	-27	40.07	164	0.014	62	0.720	-31
10	0.923	-52	35.94	149	0.026	54	0.714	-58
20	0.837	-88	27.23	129	0.040	36	0.690	-96
30	0.784	-111	20.75	117	0.046	27	0.684	-118
40	0.751	-125	16.49	108	0.048	22	0.680	-131
50	0.733	-135	13.41	103	0.050	19	0.679	-139
60	0.720	-142	11.43	99	0.050	16	0.678	-145
70	0.709	-147	9.871	96	0.050	14	0.679	-149
80	0.707	-152	8.663	93	0.051	13	0.683	-153
90	0.706	-155	7.784	91	0.051	13	0.682	-155
100	0.708	-157	7.008	88	0.051	13	0.680	-157
110	0.711	-159	6.435	86	0.051	14	0.681	-158
120	0.714	-161	5.899	85	0.051	15	0.682	-159
130	0.717	-163	5.439	82	0.052	16	0.684	-160
140	0.720	-164	5.068	80	0.052	17	0.684	-161
150	0.723	-165	4.709	80	0.052	18	0.686	-161
160	0.727	-166	4.455	78	0.052	18	0.690	-161
170	0.732	-167	4.200	77	0.052	18	0.694	-162
180	0.735	-168	3.967	75	0.052	19	0.699	-162
190	0.738	-169	3.756	74	0.052	19	0.703	-163
200	0.740	-170	3.545	73	0.052	20	0.706	-163
225	0.746	-171	3.140	69	0.053	22	0.717	-163
250	0.742	-172	2.783	67	0.053	25	0.724	-163
275	0.744	-173	2.540	64	0.054	27	0.724	-163
300	0.751	-174	2.323	60	0.055	29	0.736	-163
325	0.757	-175	2.140	58	0.058	32	0.749	-163
350	0.760	-176	1.963	54	0.059	35	0.758	-163
375	0.762	-177	1.838	52	0.062	38	0.768	-163
400	0.774	-179	1.696	50	0.065	41	0.783	-163
425	0.775	-179	1.590	48	0.068	43	0.793	-163
450	0.781	+179	1.493	46	0.071	46	0.805	-163
475	0.787	+177	1.415	43	0.074	47	0.813	-164
500	0.792	+176	1.332	40	0.079	48	0.825	-164
525	0.797	+175	1.259	38	0.083	50	0.831	-164
550	0.801	+175	1.185	37	0.088	51	0.843	-164
575	0.810	+174	1.145	36	0.094	52	0.855	-164
600	0.816	+173	1.091	34	0.101	52	0.869	-165
625	0.818	+171	1.041	32	0.106	53	0.871	-165
650	0.825	+170	0.994	30	0.112	53	0.884	-165
675	0.834	+169	0.962	29	0.119	53	0.890	-165
700	0.837	+168	0.922	27	0.127	53	0.906	-166
725	0.836	+167	0.879	25	0.133	52	0.909	-167
750	0.841	+166	0.838	25	0.140	53	0.917	-167
775	0.844	+165	0.824	24	0.148	52	0.933	-167
800	0.846	+163	0.785	21	0.154	50	0.941	-168

Figure 24. Common Source Scattering Parameters
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

MRF136

2

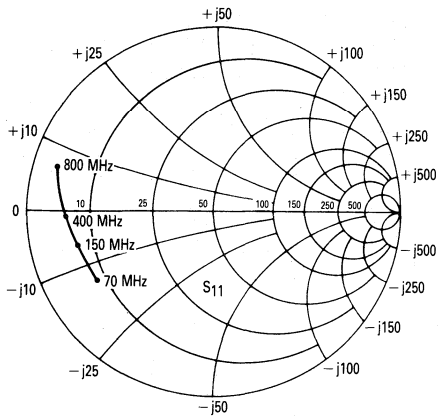


Figure 25. S_{11} , Input Reflection Coefficient versus Frequency
 $V_{DS} = 28 \text{ V}$ $I_D = 0.5 \text{ A}$

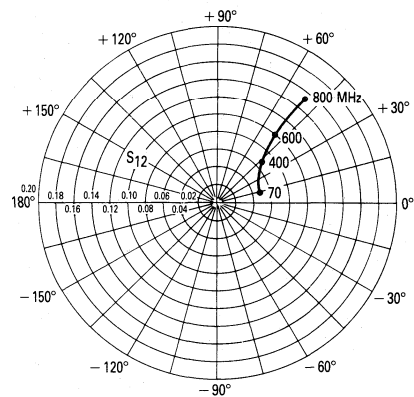


Figure 26. S_{12} , Reverse Transmission Coefficient versus Frequency
 $V_{DS} = 28 \text{ V}$ $I_D = 0.5 \text{ A}$

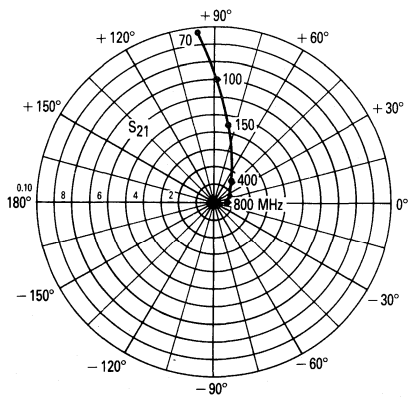


Figure 27. S_{21} , Forward Transmission Coefficient versus Frequency
 $V_{DS} = 28 \text{ V}$ $I_D = 0.5 \text{ A}$

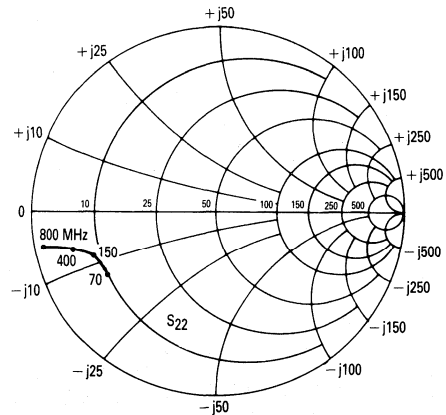


Figure 28. S_{22} , Output Reflection Coefficient versus Frequency
 $V_{DS} = 28 \text{ V}$ $I_D = 0.5 \text{ A}$

DESIGN CONSIDERATIONS

The MRF136 and MRF136Y are TMOS RF power N-Channel enhancement mode field-effect transistors (FETs) designed especially for HF and VHF power amplifier applications. Motorola TMOS FETs feature planar design for optimum manufacturability.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of TMOS RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF136 and MRF136Y are enhancement mode FETs and, therefore, do not conduct when drain voltage is applied without gate bias. A positive gate voltage causes drain current to flow (see Figure 11). RF power FETs require forward bias for optimum gain and power output. A Class AB condition with quiescent drain current (I_{DQ}) in the 25–100 mA range is sufficient for many applications. For special requirements such as linear amplification, I_{DQ} may have to be adjusted to optimize the critical parameters.

The MOS gate is a dc open circuit. Since the gate bias circuit does not have to deliver any current to the FET, a simple resistive divider arrangement may sometimes suffice for this function. Special applications may require more elaborate gate bias systems.

GAIN CONTROL

Power output of the MRF136 and MRF136Y may be controlled from rated values down to the milliwatt region (>20 dB reduction in power output with constant input power) by varying the dc gate voltage. This feature, not available in bipolar RF power devices, facilitates the incorporation of manual gain control, AGC/ALC, and mod-

ulation schemes into system designs. A full range of power output control may require dc gate voltage excursions into the negative region.

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar transistors are suitable for the MRF136 and MRF136Y. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. Both small signal scattering parameters (MRF136 only) and large signal impedance parameters are provided. Large signal impedances should be used for network designs wherever possible. While the s parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is particularly useful at frequencies outside those presented in the large signal impedance plots.

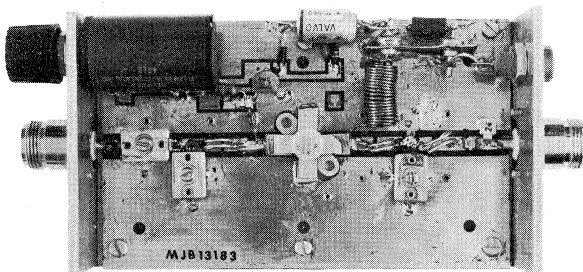
RF power FETs are triode devices and are therefore not unilateral. This, coupled with their very high gain, yields a device capable of self oscillation. Stability may be achieved using techniques such as drain loading, input shunt resistive loading, or feedback. S parameter stability analysis can provide useful information in the selection of loading and/or feedback to insure stable operation. The MRF136 was characterized with a 27 ohm input shunt loading resistor, while the MRF136Y was characterized with a resistive feedback loop around each of its two active devices.

For further discussion of RF amplifier stability and the use of two port parameters in RF amplifier design, see Motorola Application Note AN215A on page 6-204 in the RF Device Data (DL110 Rev 1).

LOW NOISE OPERATION

Input resistive loading will degrade noise performance, and noise figure may vary significantly with gate driving impedance. A low loss input matching network with its gate impedance optimized for lowest noise is recommended.

Figure 29. MRF136
Test Circuit



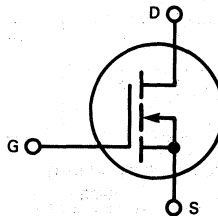
MRF137

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
 TMOS RF POWER FIELD-EFFECT TRANSISTOR**

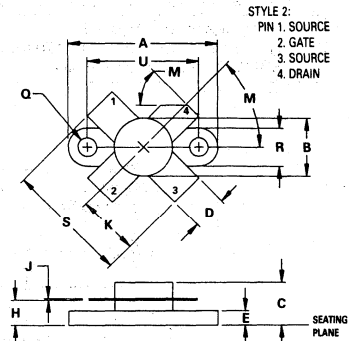
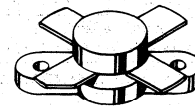
... designed for wideband large-signal output and driver stages in the 2.0 to 400 MHz range.

- Guaranteed 28 Volt, 150 MHz Performance
 Output Power = 30 Watts
 Minimum Gain = 13 dB
 Efficiency = 60% (Typical)
- Small-Signal and Large-Signal Characterization
- Typical Performance at 400 MHz, 28 Vdc, 30 W
 Output = 7.7 dB Gain
- 100% Tested for Load Mismatch at All Phase Angles
 with 30:1 VSWR
- Low Noise Figure — 1.5 dB (Typ) at 1.0 A, 150 MHz
- Excellent Thermal Stability, Ideally Suited for Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



30 W 2.0-400 MHz

**N-CHANNEL TMOS
 BROADBAND RF POWER
 FET**



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	65	Vdc
Drain-Gate Voltage ($R_{GS} = 1.0 \text{ M}\Omega$)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	5.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	100 0.571	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

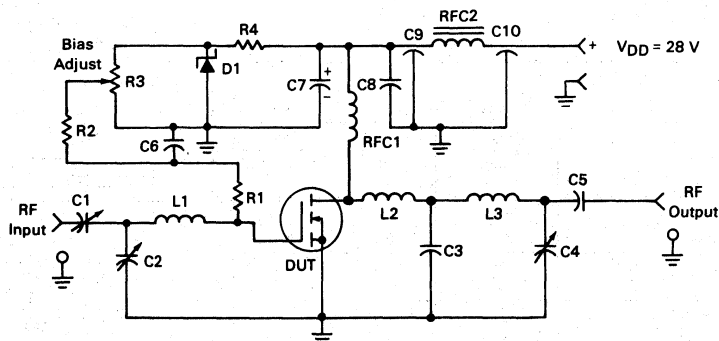
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	$^\circ\text{C}/\text{W}$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 10$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	4.0	mA _{dc}
Gate-Source Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μA_{dc}
ON CHARACTERISTICS					
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 25$ mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 500$ mA)	g_{fs}	500	750	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	48	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	54	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	11	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS} = 28$ Vdc, $I_D = 1.0$ A, $f = 150$ MHz)	NF	—	1.5	—	dB
Common Source Power Gain ($V_{DD} = 28$ Vdc, $P_{out} = 30$ W, $f = 150$ MHz (Figure 1) $I_{DQ} = 25$ mA) $f = 400$ MHz (Figure 14)	G_{ps}	13	16	—	dB
Drain Efficiency (Figure 1) ($V_{DD} = 28$ Vdc, $P_{out} = 30$ W, $f = 150$ MHz, $I_{DQ} = 25$ mA)	η	50	60	—	%
Electrical Ruggedness (Figure 1) ($V_{DD} = 28$ Vdc, $P_{out} = 30$ W, $f = 150$ MHz, $I_{DQ} = 25$ mA, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 150 MHz TEST CIRCUIT

C1 — Arco 406, 15–115 pF, or equivalent
 C2 — Arco 403, 3.0–35 pF, or equivalent
 C3 — 56 pF Mini-Unileco, or equivalent
 C4 — Arco 404, 8.0–60 pF, or equivalent
 C5 — 680 pF, 100 Mils Chip
 C6 — 0.01 μF , 100 V, Disc Ceramic
 C7 — 100 μF , 40 V
 C8 — 0.1 μF , 50 V, Disc Ceramic
 C9, C10 — 680 pF Feedthru
 D1 — 1N5925A Motorola Zener

L1 — 2 Turns, 0.29" ID, #18 AWG Enamel, Closewound
 L2 — 1 1/4 Turns, 0.2" ID, #18 AWG Enamel, Closewound
 L3 — 2 Turns, 0.2" ID, #18 AWG Enamel, Closewound
 RFC1 — 20 Turns, 0.30" ID, #20 AWG Enamel, Closewound
 RFC2 — Ferroxcube VK-200 — 19/48
 R1 — 10 k Ω , 1/2 W Thin Film
 R2 — 10 k Ω , 1/4 W
 R3 — 10 Turns, 10 k Ω
 R4 — 1.8 k Ω , 1/2 W
 Board — G10, 62 Mils

FIGURE 2 — OUTPUT POWER versus INPUT POWER

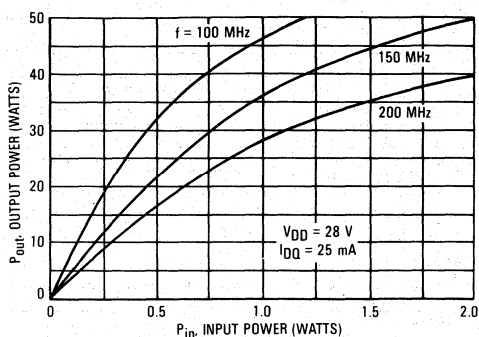


FIGURE 3 — OUTPUT POWER versus INPUT POWER

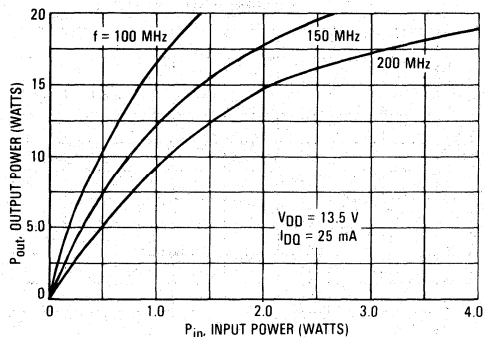


FIGURE 4 — OUTPUT POWER versus INPUT POWER

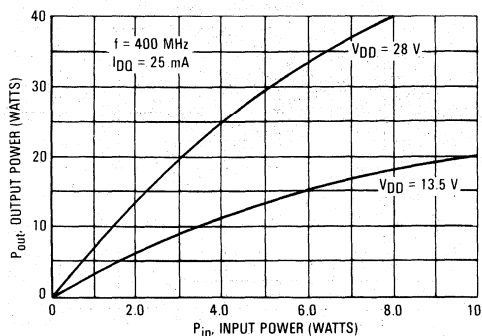
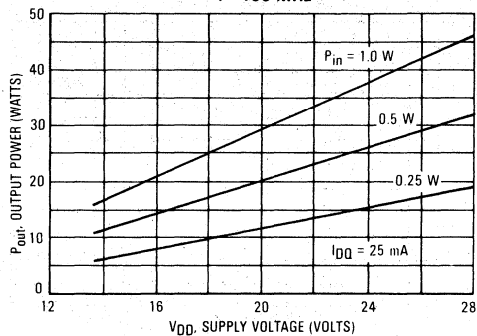
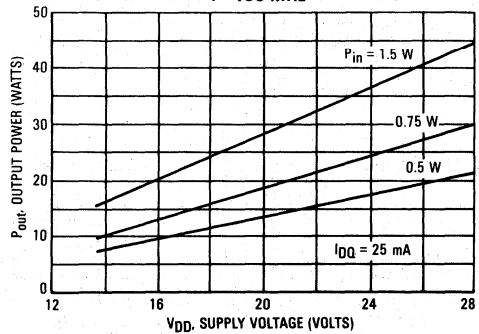
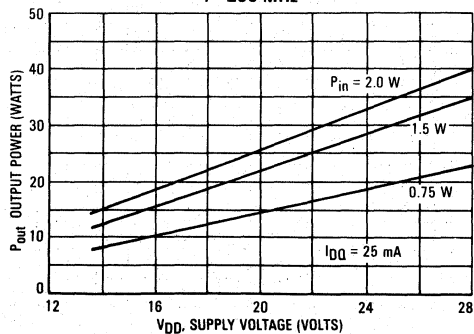
FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHzFIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 150 MHzFIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 200 MHz

FIGURE 8 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 400 \text{ MHz}$

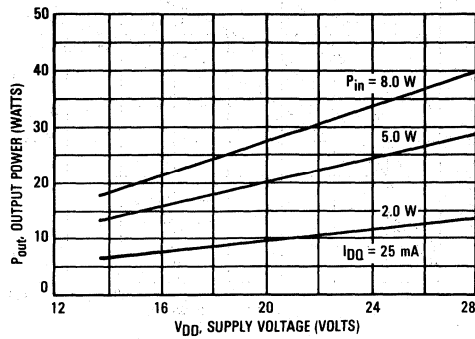


FIGURE 9 — OUTPUT POWER versus GATE VOLTAGE

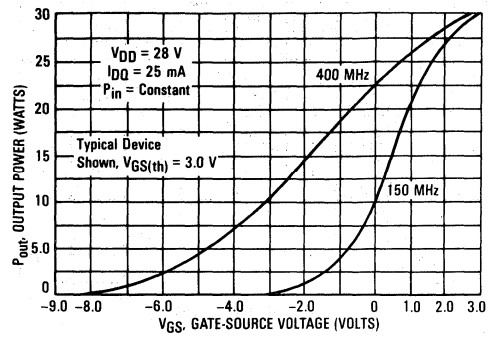


FIGURE 10 — DRAIN CURRENT versus GATE VOLTAGE
 (TRANSFER CHARACTERISTICS)

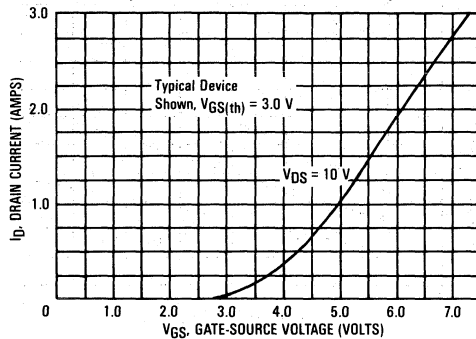


FIGURE 11 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

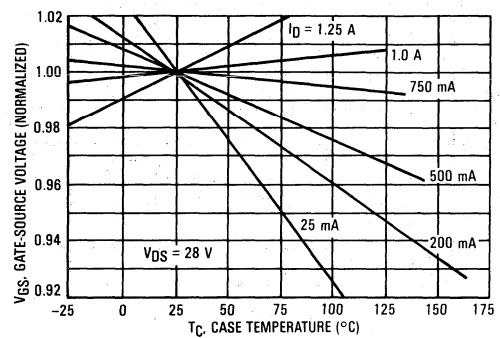


FIGURE 12 — CAPACITANCE versus DRAIN-SOURCE VOLTAGE

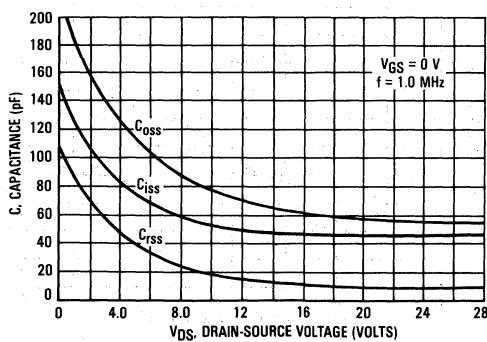


FIGURE 13 — DC SAFE OPERATING AREA

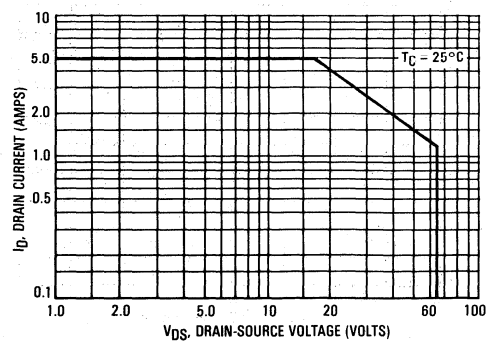
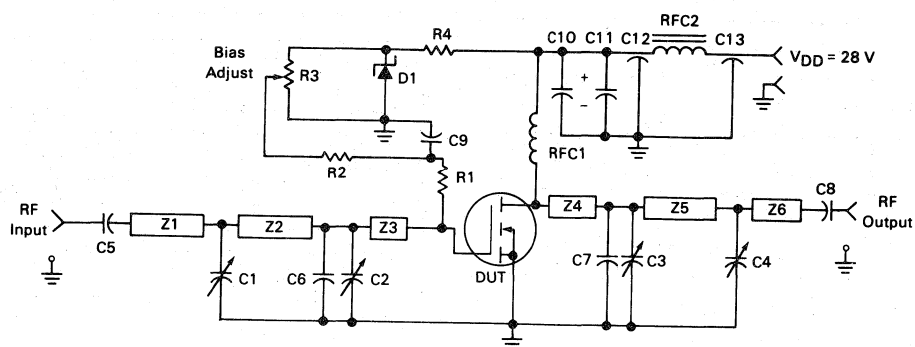


FIGURE 14 — 400 MHz TEST CIRCUIT



C1, C2, C3, C4 — 0–20 pF Johanson, or equivalent
 C5, C8 — 270 pF, 100 Mil Chip
 C6, C7 — 24 pF Mini-Unleco, or equivalent
 C9 — 0.01 μ F, 100 V, Disc Ceramic
 C10 — 100 μ F, 40 V
 C11 — 0.1 μ F, 50 V, Disc Ceramic
 C12, C13 — 680 pF Feedthru
 D1 — 1N5925A Motorola Zener
 R1, R2 — 10 k Ω , 1/4 W
 R3 — 10 Turns, 10 k Ω

R4 — 1.8 k Ω , 1/2 W
 Z1 — 2.9" \times 0.166" Microstrip
 Z2, Z4 — 0.35" \times 0.166" Microstrip
 Z3 — 0.40" \times 0.166" Microstrip
 Z5 — 1.05" \times 0.166" Microstrip
 Z6 — 1.9" \times 0.166" Microstrip
 RFC1 — 6 Turns, 0.300" ID, #20 AWG Enamel, Closewound
 RFC2 — Ferroxcube VK-200 — 19/4B
 Board — Glass Teflon, 62 Mils

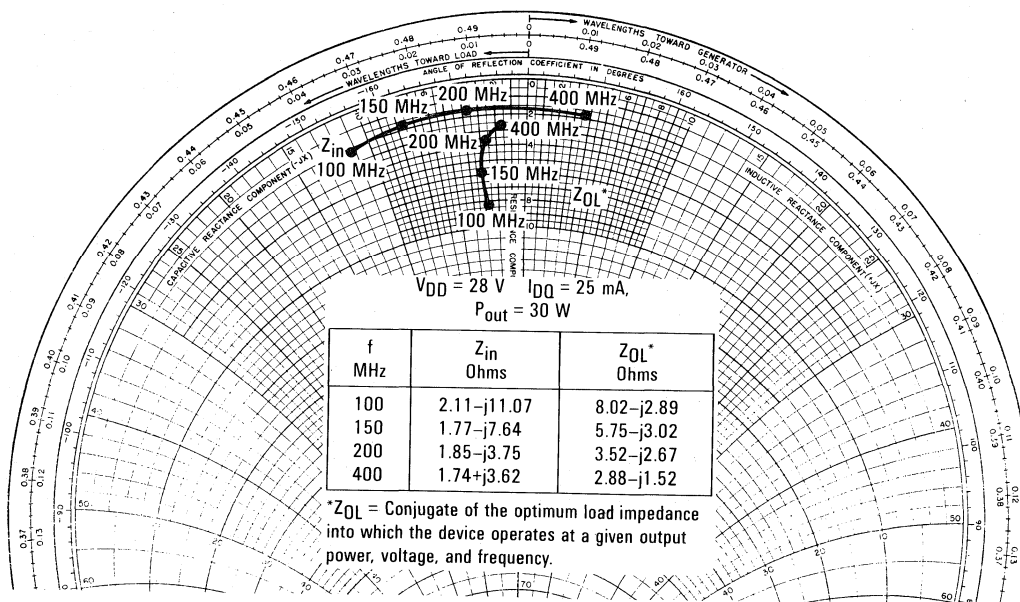
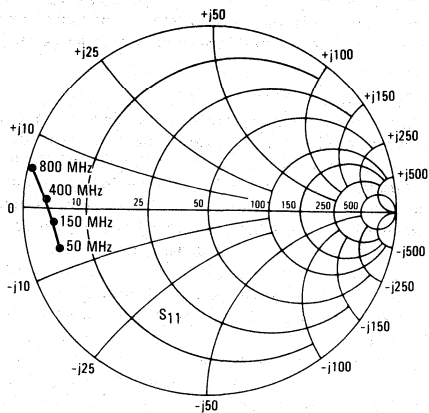
FIGURE 15 — LARGE-SIGNAL SERIES EQUIVALENT INPUT AND OUTPUT IMPEDANCE, Z_{in} , Z_{OL}^* 

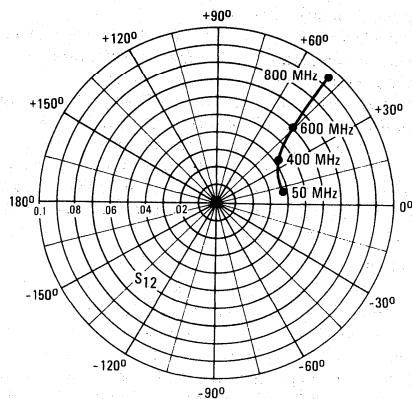
FIGURE 16 — COMMON SOURCE SCATTERING PARAMETERS
 50 Ω SYSTEM
 $V_{DS} = 28 \text{ V}$, $I_D = 0.75 \text{ A}$

f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	|S ₁₁|	$\angle\phi$	|S ₂₁|	$\angle\phi$	|S ₁₂|	$\angle\phi$	|S ₂₂|	$\angle\phi$
2.0	0.977	-32	59.48	163	0.011	67	0.661	-36
5.0	0.919	-70	48.67	142	0.024	44	0.692	-78
10	0.852	-109	33.50	122	0.032	29	0.747	-117
20	0.817	-140	19.05	106	0.037	16	0.768	-146
30	0.814	-153	13.11	99	0.038	14	0.774	-157
40	0.811	-159	9.88	95	0.038	13	0.782	-162
50	0.812	-164	7.98	92	0.038	12	0.787	-165
60	0.813	-166	6.66	89	0.038	12	0.787	-168
70	0.815	-168	5.708	86	0.038	11	0.787	-169
80	0.816	-170	5.003	84	0.038	11	0.787	-170
90	0.817	-171	4.560	83	0.038	12	0.787	-171
100	0.817	-172	4.170	81	0.039	13	0.787	-172
110	0.818	-173	3.670	80	0.039	13	0.788	-172
120	0.820	-173	3.420	79	0.039	13	0.788	-173
130	0.821	-173	3.170	79	0.039	13	0.788	-173
140	0.822	-174	2.980	78	0.039	13	0.788	-173
150	0.823	-175	2.826	77	0.039	14	0.788	-173
160	0.824	-175	2.650	76	0.039	14	0.790	-174
170	0.825	-176	2.438	75	0.039	14	0.792	-174
180	0.827	-176	2.325	73	0.039	15	0.793	-174
190	0.829	-177	2.175	72	0.039	16	0.796	-174
200	0.831	-177	2.084	71	0.039	16	0.799	-174
225	0.836	-178	1.824	69	0.039	18	0.805	-174
250	0.846	-178	1.621	66	0.039	21	0.816	-174
275	0.853	-179	1.462	64	0.039	23	0.822	-174
300	0.853	-179	1.319	61	0.040	25	0.833	-174
325	0.856	-179	1.194	59	0.040	27	0.828	-174
350	0.857	+179	1.089	56	0.040	30	0.842	-174
375	0.861	+179	1.014	54	0.042	32	0.849	-174
400	0.865	+178	0.927	51	0.043	35	0.856	-174
425	0.875	+178	0.876	49	0.045	37	0.866	-174
450	0.881	+178	0.810	46	0.046	40	0.870	-174
475	0.886	+177	0.755	44	0.046	43	0.875	-174
500	0.887	+177	0.694	41	0.051	43	0.888	-174
525	0.888	+176	0.677	39	0.052	43	0.890	-174
550	0.896	+176	0.625	36	0.055	45	0.898	-174
575	0.907	+175	0.603	34	0.058	45	0.913	-174
600	0.910	+175	0.585	32	0.061	45	0.918	-174
625	0.910	+174	0.563	30	0.065	45	0.945	-174
650	0.920	+174	0.543	28	0.069	46	0.952	-174
675	0.938	+173	0.533	26	0.074	47	0.974	-174
700	0.943	+171	0.515	24	0.078	47	0.958	-176
725	0.934	+170	0.491	22	0.079	46	0.953	-177
750	0.940	+170	0.475	22	0.084	48	0.943	-177
775	0.953	+169	0.477	21	0.090	48	0.957	-177
800	0.959	+168	0.467	17	0.093	48	0.957	-179

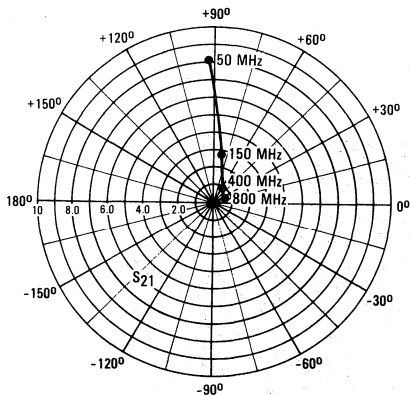
**FIGURE 17 — S_{11} , INPUT REFLECTION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 0.75 \text{ A}$



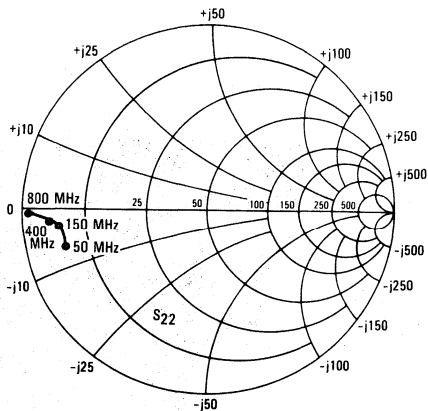
**FIGURE 18 — S_{12} , REVERSE TRANSMISSION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 0.75 \text{ A}$



**FIGURE 19 — S_{21} , FORWARD TRANSMISSION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 0.75 \text{ A}$



**FIGURE 20 — S_{22} , OUTPUT REFLECTION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 0.75 \text{ A}$



DESIGN CONSIDERATIONS

The MRF137 is a TMOS RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for VHF power amplifier applications. Motorola TMOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of TMOS RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF137 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 10 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF137 was characterized at $I_{DQ} = 25$ mA, which is the suggested minimum value of I_{DQ} . For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a

simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

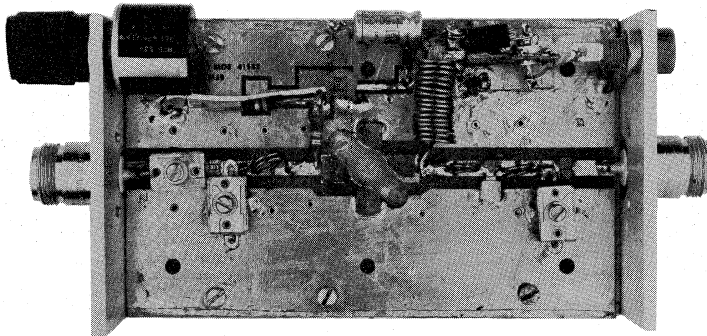
Power output of the MRF137 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC, and modulation systems. (See Figure 9.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF137. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of TMOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of TMOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF137, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF137 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two port network theory and stability.

FIGURE 21 — 150 MHz TEST CIRCUIT



MRF138

The RF TMOS Line

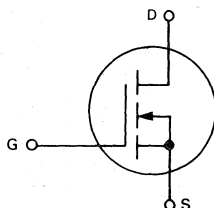
**N-CHANNEL ENHANCEMENT-MODE
 TMOS RF POWER FIELD-EFFECT TRANSISTOR**

... designed for power amplifier applications in industrial, commercial and amateur radio equipment to 175 MHz.

- Superior High Order IMD
- Specified 28 Volts, 30 MHz Characteristics

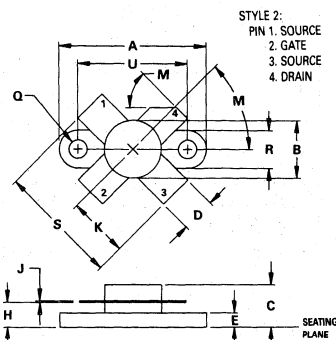
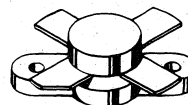
Output Power = 30 Watts
 Power Gain = 17 dB (Typ)
 Efficiency = 40% (Typ)

- IMD(d3) (30 W PEP) = -30 dB (Typ)
- IMD(d11) (30 W PEP) = -60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR



30 W 2.0-175 MHz

**N-CHANNEL TMOS
 LINEAR RF POWER
 FET**



NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	65	Vdc
Drain-Gate Voltage ($R_{GS} = 1.0 \text{ M}\Omega$)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	6.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	115 0.66	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	$^\circ\text{C}/\text{W}$
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.			

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 10$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	5.0	mA _{dc}
Gate-Source Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	—	100	nA _{dc}

ON CHARACTERISTICS

Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 10$ mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Drain-Source On-Voltage ($V_{GS} = 10$ V, $I_D = 2.5$ A)	$V_{DS(on)}$	—	—	2.5	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 2.5$ A)	g_{fs}	0.8	1.2	—	mhos

DYNAMIC CHARACTERISTICS

Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$ V, $f = 1.0$ MHz)	C_{iss}	—	55	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	70	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	14	—	pF

FUNCTIONAL TESTS (SSB)

Common Source Amplifier Power Gain ($V_{DD} = 28$ V, $P_{out} = 30$ W (PEP), $I_{DQ} = 100$ mA) (30 MHz) (Fig. 1) (150 MHz) (Fig. 6)	G_{ps}	—	17	—	dB
Drain Efficiency (Figure 1) ($V_{DD} = 28$ V, $f = 30$ MHz, $I_{DQ} = 100$ mA)	η	—	40	—	%
Intermodulation Distortion (Figure 1) ($V_{DD} = 28$ V, $P_{out} = 30$ W (PEP), $f = 30$; 30.001 MHz, $I_{DQ} = 100$ mA)	IMD(d3) IMD(d11)	—	-30 -60	—	dB
Load Mismatch (Figure 1) ($V_{DD} = 28$ V, $P_{out} = 30$ W (PEP), $f = 30$; 30.001 MHz, $I_{DQ} = 100$ mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

CLASS A PERFORMANCE

Intermodulation Distortion (1) and Power Gain ($V_{DD} = 28$ V, $P_{out} = 10$ W (PEP), $f_1 = 30$ MHz, $f_2 = 30.001$ MHz, $I_{DQ} = 1.0$ A)	G_{ps} IMD(d3) IMD(d9-13)	— — —	20 -50 -70	— — —	dB
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(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

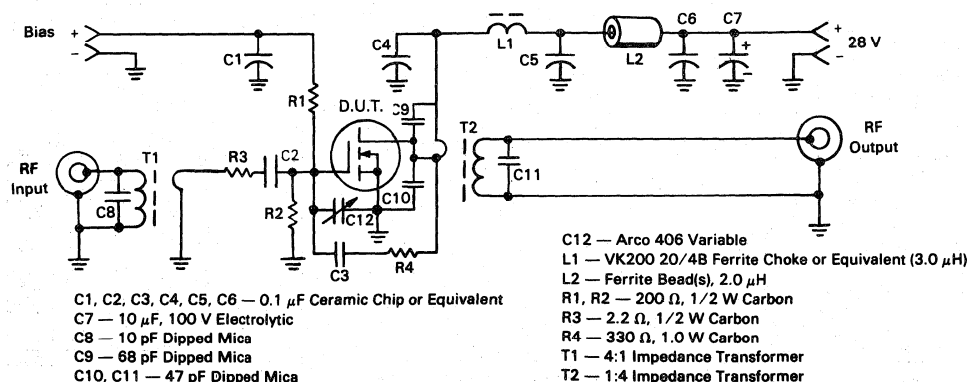
FIGURE 1 — 2-50 MHz BROADBAND TEST CIRCUIT

FIGURE 2 — POWER GAIN versus FREQUENCY

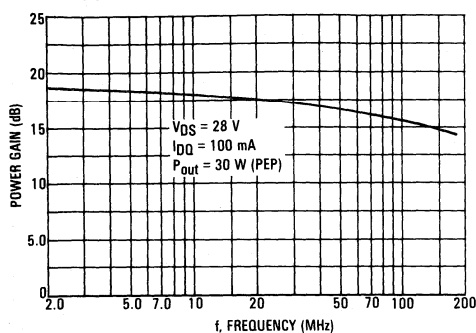


FIGURE 3 — OUTPUT POWER versus INPUT POWER

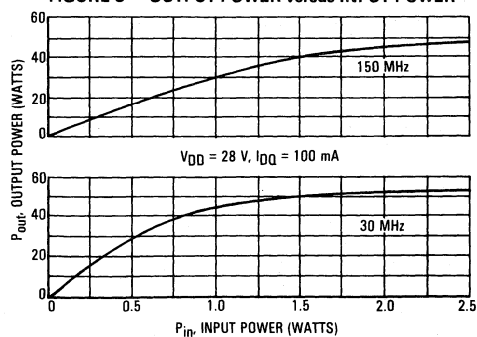
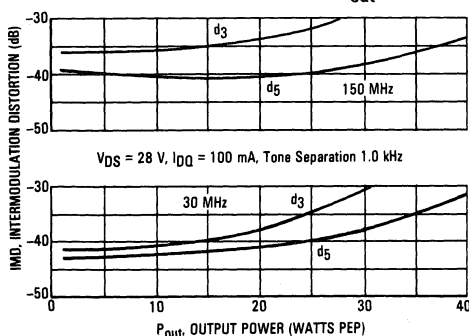
FIGURE 4 — IMD versus P_{out}

FIGURE 5 — COMMON SOURCE UNITY CURRENT GAIN FREQUENCY versus DRAIN CURRENT

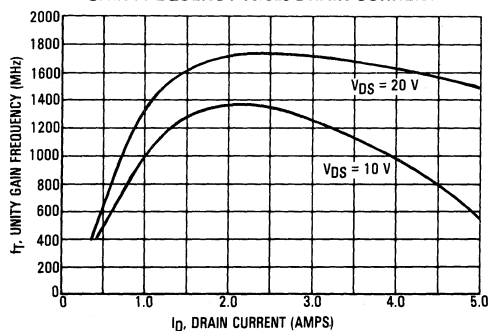


FIGURE 6 — 150 MHz TEST CIRCUIT

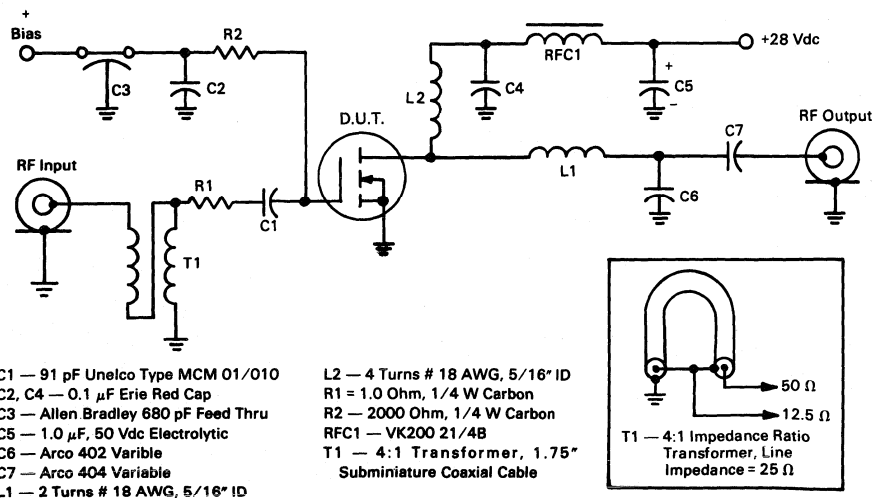


FIGURE 7 — GATE VOLTAGE versus DRAIN CURRENT

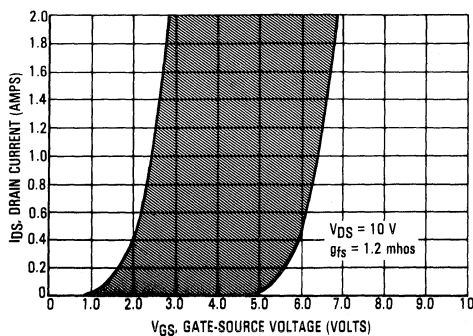
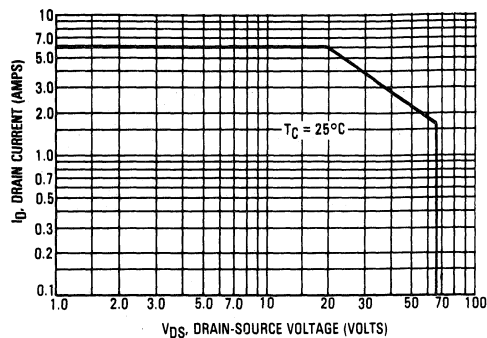
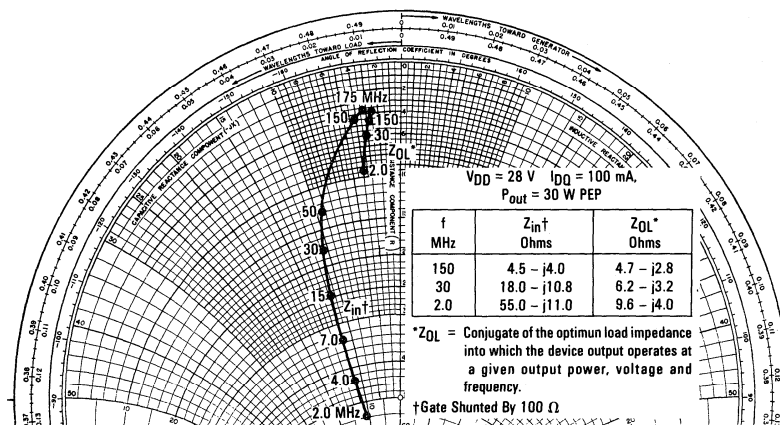


FIGURE 8 — DC SAFE OPERATING AREA

FIGURE 9 — LARGE-SIGNAL SERIES EQUIVALENT
INPUT/OUTPUT IMPEDANCE, Z_{in}^\dagger , Z_{OL}^* 

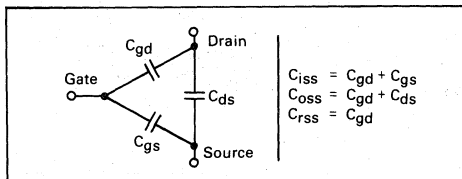
TMOS POWER FET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the TMOS FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the TMOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

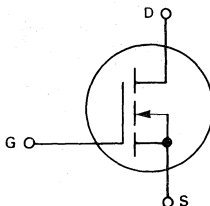
MRF140

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
 TMOS RF POWER FIELD-EFFECT TRANSISTOR**

... designed primarily for linear large-signal output stages in the 2-150 MHz frequency range.

- Specified 28 Volts, 30 MHz Characteristics
 - Output Power = 150 Watts
 - Power Gain = 15 dB (Typ)
 - Efficiency = 40% (Typ)
- Superior High Order IMD
- $IMD_{(d3)}$ (150 W PEP) = -30 dB Typ
- $IMD_{(d11)}$ (150 W PEP) = -60 dB Typ
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR



MAXIMUM RATINGS

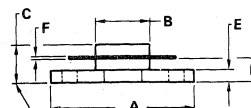
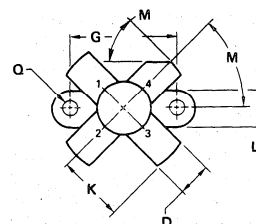
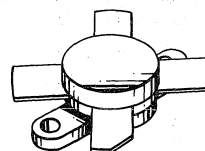
Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	65	Vdc
Drain — Gate Voltage	V_{DGO}	65	Vdc
Gate — Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ $T_C = 25^\circ C$ Derate above $25^\circ C$	P_D	300 1.7	Watts W/ $^\circ C$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ C$
Operating Junction Temperature	T_J	200	$^\circ C$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	$^\circ C/W$
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.			

150 W 2.0-150 MHz

**N-CHANNEL TMOS
 LINEAR RF POWER
 FET**



SEATING PLANE

STYLE 2:

- PIN 1. SOURCE
- 2. GATE
- 3. SOURCE
- 4. DRAIN

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.15	0.960	0.990
B	11.81	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.46	5.97	0.216	0.235
E	2.13	2.79	0.084	0.110
F	0.08	0.18	0.003	0.007
G	18.29	18.54	0.720	0.730
K	11.05	—	0.435	—
L	6.22	6.48	0.246	0.255
M	45° NOM	45° NOM		
N	3.66	4.52	0.144	0.178
Q	2.92	3.30	0.115	0.130

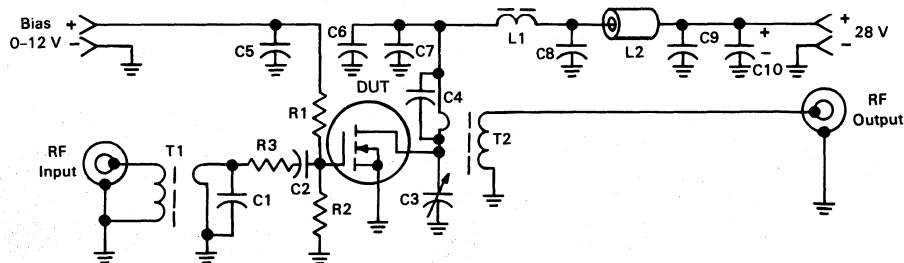
CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ Vdc, $V_{GS} = 0$)	I_{DSS}	—	—	5.0	mA _{dc}
Gate-Body Leakage Current ($V_{GS} = 20$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μA_{dc}
ON CHARACTERISTICS					
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 100$ mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage ($V_{GS} = 10$ V, $I_D = 10$ A _{dc})	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 5.0$ A)	g_{fs}	4.0	—	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	450	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	450	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	100	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain ($V_{DD} = 28$ V, $P_{out} = 150$ W (PEP), $I_{DQ} = 250$ mA) (30 MHz) (150 MHz)	G_{ps}	—	15 6.0	—	dB
Drain Efficiency ($V_{DD} = 28$ V, $P_{out} = 150$ W (PEP), $f = 30$; 30.001 MHz, I_D (Max) = 6.5 A)	η	—	40	—	%
Intermodulation Distortion (1) ($V_{DD} = 28$ V, $P_{out} = 150$ W (PEP), $f_1 = 30$ MHz, $f_2 = 30.001$ MHz, $I_{DQ} = 250$ mA)	IMD _(d3) IMD _(d11)	—	-30 -60	—	dB
Load Mismatch ($V_{DD} = 28$ V, $P_{out} = 150$ W (PEP), $f = 30$; 30.001 MHz, $I_{DQ} = 250$ mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT (CLASS AB)



C1 — 820 pF Dipped Mica
 C2, C5, C6, C7, C8, C9 — 0.1 μF Ceramic Chip or Monolithic with Short Leads
 C3 — Arco 469
 C4 — 560 pF Unencapsulated Mica or Dipped Mica with Short Leads
 C10 — 10 μF /100 V Electrolytic

L1 — VK200/4B Ferrite Choke or Equivalent, 3.0 μH
 L2 — Ferrite Bead(s), 2.0 μH
 R1, R2 — 51 Ω /1.0 W Carbon
 R3 — 1.0 Ω /1.0 W Carbon
 T1 — 16:1 Broadband Transformer
 T2 — 1:25 Broadband Transformer

FIGURE 2 — POWER GAIN versus FREQUENCY

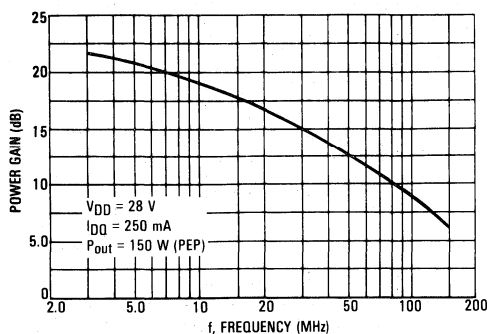


FIGURE 3 — OUTPUT POWER versus INPUT POWER

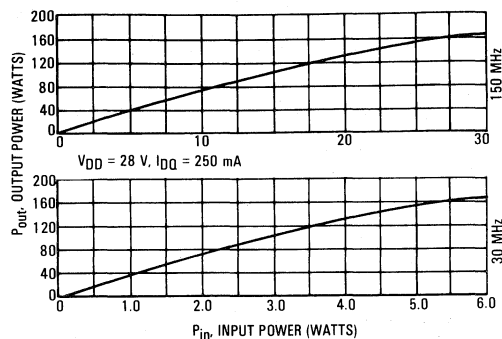
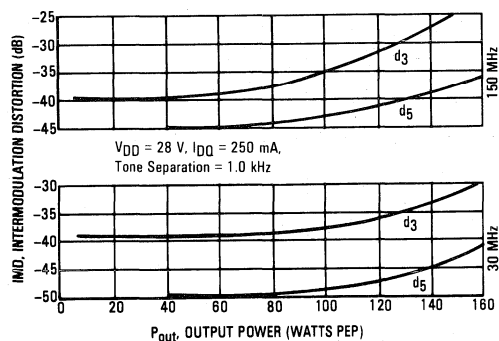
FIGURE 4 — IMD versus P_{out} 

FIGURE 5 — COMMON SOURCE UNITY GAIN FREQUENCY versus DRAIN CURRENT

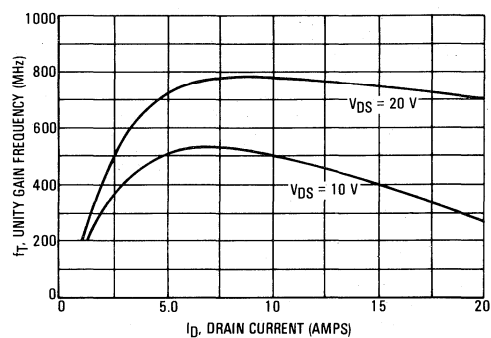


FIGURE 6 — GATE VOLTAGE versus DRAIN CURRENT

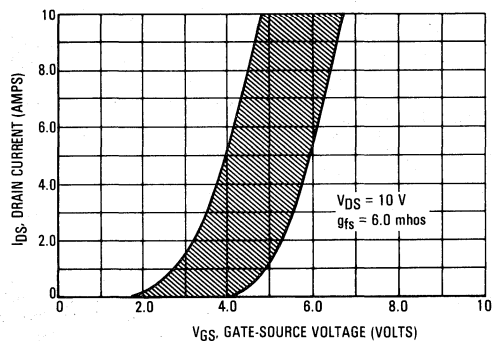
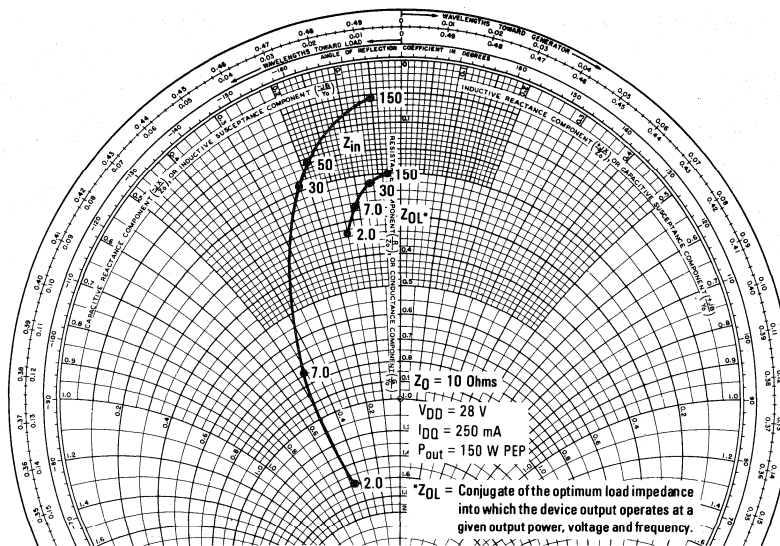
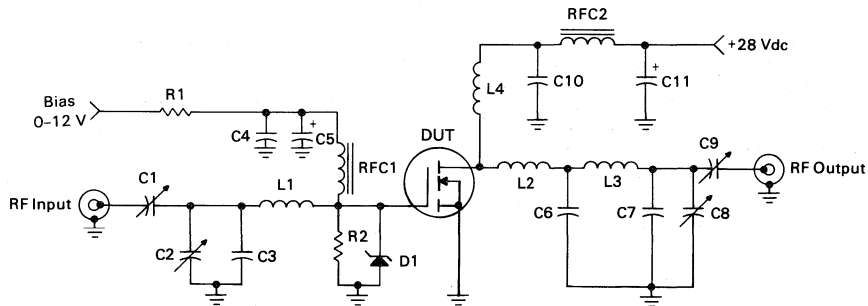


FIGURE 7 — SERIES EQUIVALENT IMPEDANCE



NOTE: Gate Shunted by 25 Ohms.

FIGURE 8 — 150 MHz TEST CIRCUIT (CLASS AB)



C1, C2, C8 — Arco 463 or equivalent
 C3 — 25 pF Unelco
 C4 — 0.1 μF Ceramic
 C5 — 1.0 μF , 15 WV Tantalum
 C6 — 150 pF Unelco J101
 C7 — 25 μF Unelco J101
 C9 — Arco 262 or equivalent
 C10 — 0.05 μF Ceramic
 C11 — 15 μF , 35 WV Electrolytic

L1 — 3/4" #18 AWG into Hairpin
 L2 — Printed Line, 0.200" \times 0.500"
 L3 — 7/8" #16 AWG into Hairpin
 L4 — 2 Turns #16 AWG, 5/16 ID
 RFC1 — 5.6 μH Molded Choke
 RFC2 — VK200-4B
 R1, R2 — 150 Ω , 1.0 W Carbon

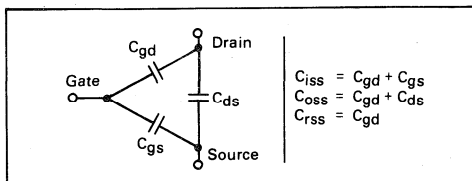
TMOS POWER FET CONSIDERATIONS

MOSFET CAPACITANCES

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These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

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The gate of the TMOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

Advance Information

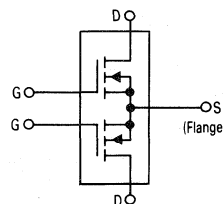
The RF TMOS Line

RF Power Field-Effect Transistor

N-Channel Enhancement-Mode TMOS

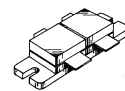
... designed for broadband commercial and military applications using push-pull circuits in the 2–175 MHz frequency band. The high power, high gain and broadband performance of each device makes possible solid-state transmitters for FM broadcast or TV channel frequency bands.

- Push-Pull Package for Broadband Circuits
- Low Thermal Resistance — 0.35°C/W Max
- Ruggedness Tested at Rated Output Power
- Nitride Passivation
- All Aluminum Metal System for High Reliability



MRF141G

300 W, 28 V, 2–175 MHz
N-CHANNEL
TMOS BROADBAND
RF POWER FET



CASE 375-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGO}	65	Vdc
Gate-Source Voltage	V_{GS}	± 20	Vdc
Drain Current — Continuous	I_D	40	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	500 2.85	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to $+150$	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.35	°C/W
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.			

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS (Each Side)

Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ Vdc, $V_{GS} = 0$)	I_{DSS}	—	—	5	mAdc
Gate-Body Leakage Current ($V_{GS} = 20$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	—	1	μAdc

This document contains information on a new product. Specifications and information herein are subject to change without notice.

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

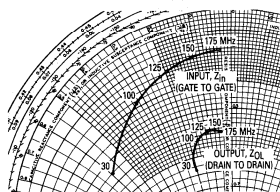
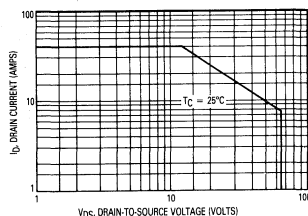
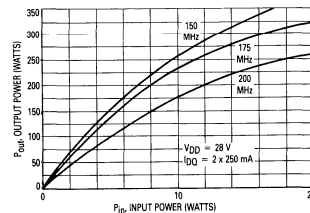
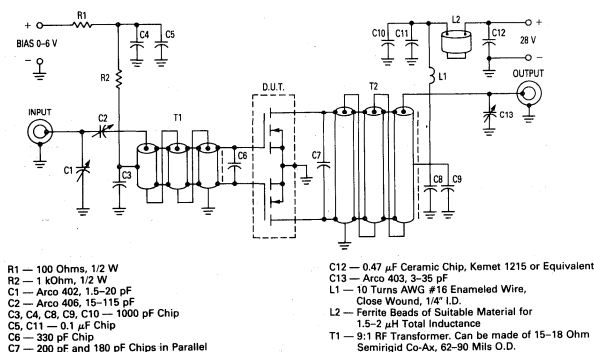
Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Each Side)					
Gate Threshold Voltage ($V_{DS} = 10\text{ V}$, $I_D = 100\text{ mA}$)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage ($V_{GS} = 10\text{ V}$, $I_D = 10\text{ Adc}$)	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance ($V_{DS} = 10\text{ V}$, $I_D = 5\text{ A}$)	g_{fs}	5	7	—	mhos

DYNAMIC CHARACTERISTICS (Each Side)

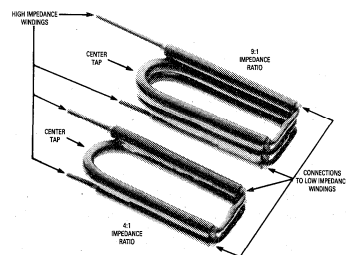
Input Capacitance ($V_{DS} = 28\text{ V}$, $V_{GS} = 0$, $f = 1\text{ MHz}$)	C_{iss}	—	375	—	pF
Output Capacitance ($V_{DS} = 28\text{ V}$, $V_{GS} = 0$, $f = 1\text{ MHz}$)	C_{oss}	—	400	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28\text{ V}$, $V_{GS} = 0$, $f = 1\text{ MHz}$)	C_{rss}	—	45	—	pF

FUNCTIONAL TESTS

Common Source Amplifier Power Gain ($V_{DD} = 28\text{ V}$, $P_{out} = 300\text{ W}$, $I_{DQ} = 500\text{ mA}$, $f = 175\text{ MHz}$)	G_{ps}	—	13	—	dB
Drain Efficiency ($V_{DD} = 28\text{ V}$, $P_{out} = 300\text{ W}$, $f = 175\text{ MHz}$, $I_D(\text{Max}) = 19.5\text{ A}$)	η	—	55	—	%
Load Mismatch ($V_{DD} = 28\text{ V}$, $P_{out} = 300\text{ W}$, $I_{DQ} = 500\text{ mA}$, VSWR 5:1 at all Phase Angles)	ψ	No Degradation in Output Power			

**Figure 1. Input and Output Impedance****Figure 2. DC Safe Operating Area****Figure 3. Output Power versus Input Power**

Unless Otherwise Noted, All Chip Capacitors are ATC Type 100 or Equivalent.

Figure 4. 175 MHz Test Circuit

T2 — 1:9 RF Transformer, Can be made of 15–18 Ohm Semirigid Co-Ax, 90–100 Mils O.D.

NOTE: For stability, the input transformer T1 must be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz, the same is required for the output transformer.

See picture for construction details.

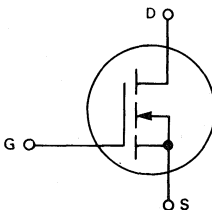
MRF148

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
 TMOS RF POWER FIELD-EFFECT TRANSISTOR**

... designed for power amplifier applications in industrial, commercial and amateur radio equipment to 175 MHz.

- Superior High Order IMD
- Specified 50 Volts, 30 MHz Characteristics
 - Output Power = 30 Watts
 - Power Gain = 18 dB (Typ)
 - Efficiency = 40% (Typ)
- $IMD_{(d3)}$ (30 W PEP) = -35 dB (Typ)
- $IMD_{(d11)}$ (30 W PEP) = -60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	120	Vdc
Drain — Gate Voltage	V_{DGO}	120	Vdc
Gate — Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	6.0	Adc
Total Device Dissipation @ $T_C = 25^\circ C$ Derate above $25^\circ C$	P_D	115 0.66	Watts W/ $^\circ C$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ C$
Operating Junction Temperature	T_J	200	$^\circ C$

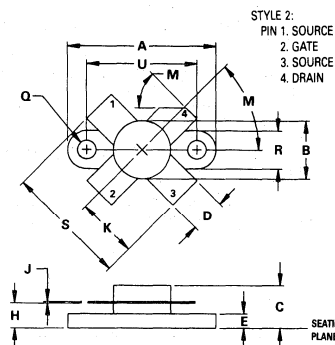
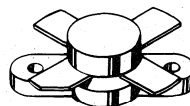
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	$^\circ C/W$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

30 W 2.0-175 MHz

**N-CHANNEL TMOS
 LINEAR RF POWER
 FET**



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

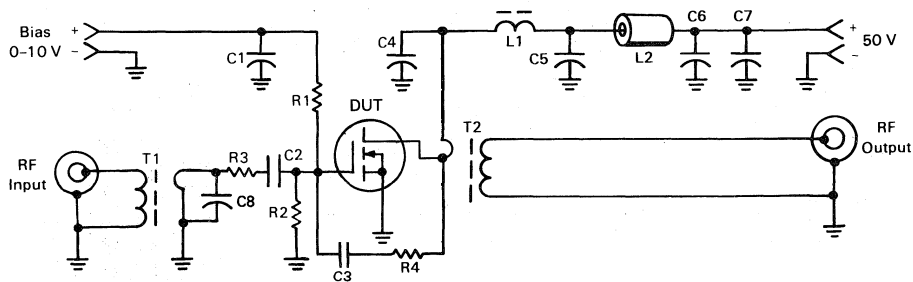
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V _{GS} = 0, I _D = 10 mA)	V _{(BR)DSS}	125	—	—	V _{dc}
Zero Gate Voltage Drain Current (V _{DS} = 50 V, V _{GS} = 0.)	I _{DSS}	—	—	1.0	mAdc
Gate-Body Leakage Current (V _{GS} = 20 V, V _{DS} = 0)	I _{GSS}	—	—	100	nAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V _{DS} = 10 V, I _D = 10 mA)	V _{GS(th)}	1.0	3.0	5.0	V _{dc}
Drain-Source On-Voltage (V _{GS} = 10 V, I _D = 2.5 A)	V _{DS(on)}	—	—	5.0	V _{dc}
Forward Transconductance (V _{DS} = 10 V, I _D = 2.5 A)	g _{fs}	0.8	1.2	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V _{DS} = 50 V, V _{GS} = 0 V, f = 1.0 MHz)	C _{iss}	—	50	—	pF
Output Capacitance (V _{DS} = 50 V, V _{GS} = 0, f = 1.0 MHz)	C _{oss}	—	35	—	pF
Reverse Transfer Capacitance (V _{DS} = 50 V, V _{GS} = 0, f = 1.0 MHz)	C _{rss}	—	8.0	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain (V _{DD} = 50 V, P _{out} = 30 W (PEP), I _{DQ} = 100 mA) (30 MHz)	G _{ps}	—	18	—	dB
		—	15	—	
Drain Efficiency (V _{DD} = 50 V, f = 30 MHz, I _{DQ} = 100 mA) (30 W PEP)	η	—	40	—	%
		—	50	—	
Intermodulation Distortion (V _{DD} = 50 V, P _{out} = 30 W (PEP), f = 30; 30.001 MHz, I _{DQ} = 100 mA)	IMD _(d3) IMD _(d11)	—	-35 -60	—	dB
Load Mismatch (V _{DD} = 50 V, P _{out} = 30 W (PEP), f = 30; 30.001 MHz, I _{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V _{DD} = 50 V, P _{out} = 10 W (PEP), f ₁ = 30 MHz, f ₂ = 30.001 MHz, I _{DQ} = 1.0 A)	G _{PS} IMD _(d3) IMD _(d9-13)	— — —	20 -50 -70	— — —	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 2-50 MHz BROADBAND TEST CIRCUIT

C1, C2, C3, C4, C5, C6 — 0.1 μF Ceramic Chip or Equivalent
 C7 — 10 μF , 100 V Electrolytic
 C8 — 100 pF Dipped Mica
 L1 — VK200 20/4B Ferrite Choke or Equivalent (3.0 μH)
 L2 — Ferrite Bead(s), 2.0 μH

R1, R2 — 200 Ω , 1/2 W Carbon
 R3 — 4.7 Ω , 1/2 W Carbon
 R4 — 470 Ω , 1.0 W Carbon
 T1 — 4:1 Impedance Transformer
 T2 — 1:2 Impedance Transformer

FIGURE 2 — POWER GAIN versus FREQUENCY

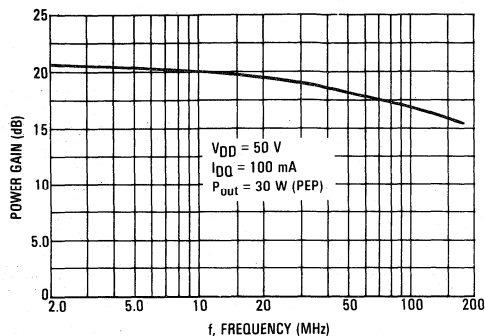


FIGURE 3 — OUTPUT POWER versus INPUT POWER

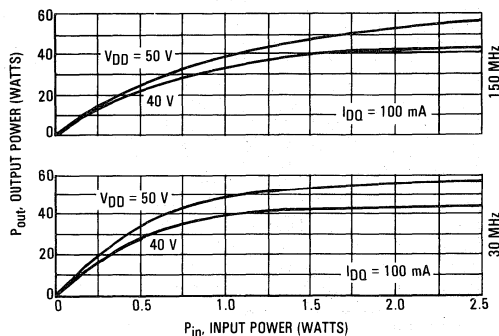
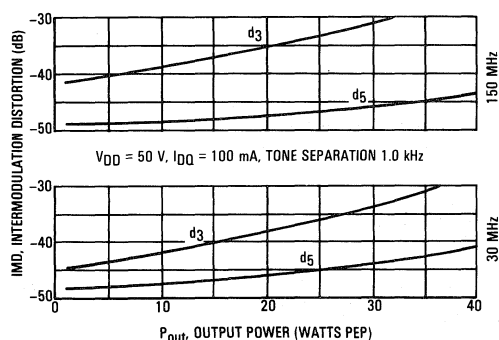
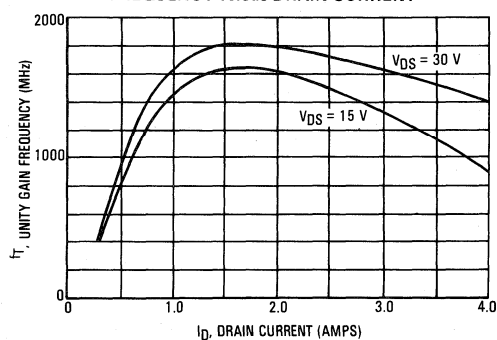
FIGURE 4 — IMD versus P_{out}FIGURE 5 — COMMON SOURCE UNITY GAIN
FREQUENCY versus DRAIN CURRENT

FIGURE 6 — 150 MHz TEST CIRCUIT

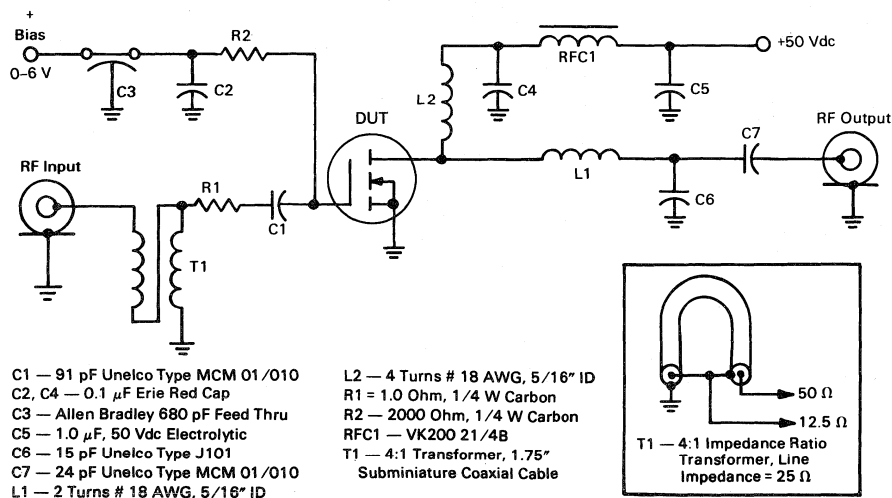


FIGURE 7 — GATE VOLTAGE versus DRAIN CURRENT

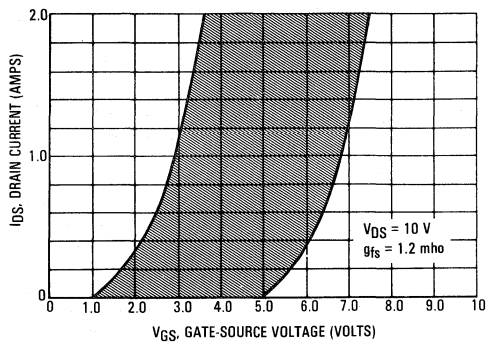


FIGURE 8 — DC SAFE OPERATING AREA (SOA)

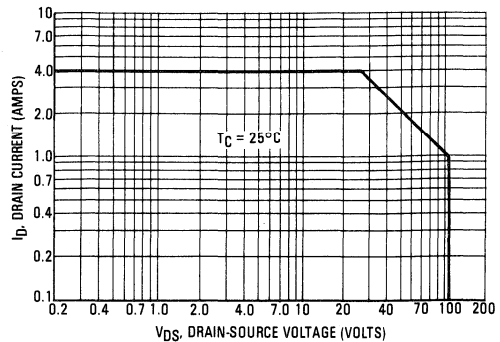
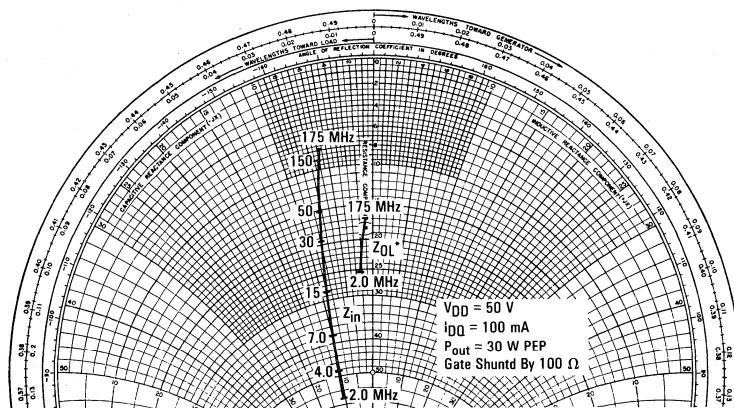


FIGURE 9 — IMPEDANCE COORDINATES — 50-OHM CHARACTERISTIC IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

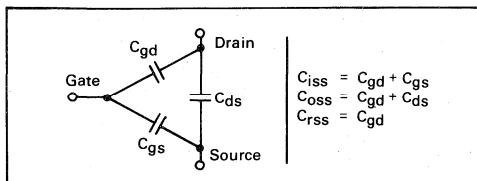
TMOS POWER FET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the TMOS FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the TMOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

MRF150

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
 TMOS RF POWER FIELD-EFFECT TRANSISTOR**

... designed primarily for linear large-signal output stages in the 2-175 MHz frequency range.

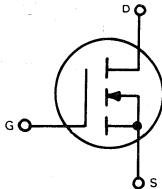
- Specified 50 Volts, 30 MHz Characteristics

Output Power = 150 Watts

Power Gain = 17 dB (Typ)

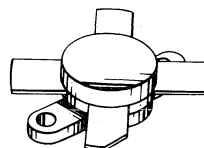
Efficiency = 45% (Typ)

- Superior High Order IMD
- $IMD_{(d3)}$ (150 W PEP) = -32 dB (Typ)
- $IMD_{(d11)}$ (150 W PEP) = -60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR



150 W 2.0-175 MHz

**N-CHANNEL TMOS
 LINEAR RF POWER
 FET**



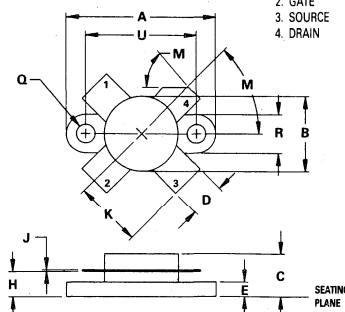
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DS}	125	Vdc
Drain — Gate Voltage	V_{DG}	125	Vdc
Gate — Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	300 1.71	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	$^\circ\text{C/W}$
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.			

STYLE 2:
 PIN 1. SOURCE
 PIN 2. GATE
 PIN 3. SOURCE
 PIN 4. DRAIN



NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100$ mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 50$ V, $V_{GS} = 0$)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μAdc

ON CHARACTERISTICS

Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 100$ mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage ($V_{GS} = 10$ V, $I_D = 10$ A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 5.0$ A)	g_{fs}	4.0	5.0	—	mhos

DYNAMIC CHARACTERISTICS

Input Capacitance ($V_{DS} = 50$ V, $V_{GS} = 0$ V, $f = 1.0$ MHz)	C_{iss}	—	350	—	pF
Output Capacitance ($V_{DS} = 50$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	250	—	pF
Reverse Transfer Capacitance ($V_{DS} = 50$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	50	—	pF

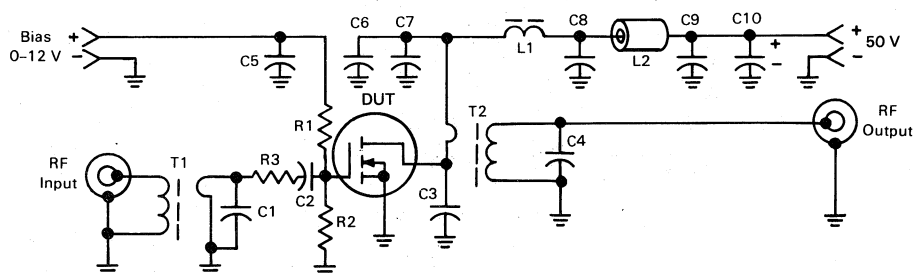
FUNCTIONAL TESTS (SSB)

Common Source Amplifier Power Gain ($V_{DD} = 50$ V, $P_{out} = 150$ W (PEP), $I_{DQ} = 250$ mA)	G_{ps}	—	17 8.0	—	dB
Drain Efficiency ($V_{DD} = 50$ V, $P_{out} = 150$ W (PEP), $f = 30$; 30.001 MHz, I_D (Max) = 3.75 A)	η	—	45	—	%
Intermodulation Distortion (1) ($V_{DD} = 50$ V, $P_{out} = 150$ W (PEP), $f_1 = 30$ MHz, $f_2 = 30.001$ MHz, $I_{DQ} = 250$ mA)	IMD(d3) IMD(d11)	—	—32 —60	—	dB
Load Mismatch ($V_{DD} = 50$ V, $P_{out} = 150$ W (PEP), $f = 30$; 30.001 MHz, $I_{DQ} = 250$ mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

CLASS A PERFORMANCE

Intermodulation Distortion (1) and Power Gain ($V_{DD} = 50$ V, $P_{out} = 50$ W (PEP), $f_1 = 30$ MHz, $f_2 = 30.001$ MHz, $I_{DQ} = 3.0$ A)	G_{ps} IMD(d3) IMD(d9-13)	—	20 —50 —75	—	dB
--	-----------------------------------	---	------------------	---	----

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT (CLASS AB)

C1 — 470 pF Dipped Mica
 C2, C5, C6, C7, C8, C9 — 0.1 μF Ceramic Chip or Monolithic with Short Leads
 C3 — 200 pF Unencapsulated Mica or Dipped Mica with Short Leads
 C4 — 15 pF Unencapsulated Mica or Dipped Mica with Short Leads

C10 — 10 μF /100 V Electrolytic
 L1 — VK200/4B Ferrite Choke or Equivalent, 3.0 μH
 L2 — Ferrite Bead(s), 2.0 μH
 R1, R2 — 51 Ω /1.0 W Carbon
 R3 — 3.3 Ω /1.0 W Carbon (or $2 \times 6.8 \Omega$ /1/2 W in Parallel)
 T1 — 9:1 Broadband Transformer
 T2 — 1:9 Broadband Transformer

FIGURE 2 — POWER GAIN versus FREQUENCY

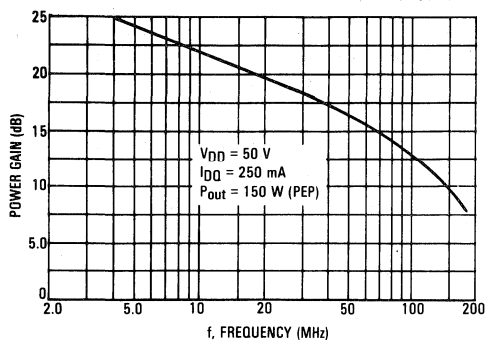


FIGURE 3 — OUTPUT POWER versus INPUT POWER

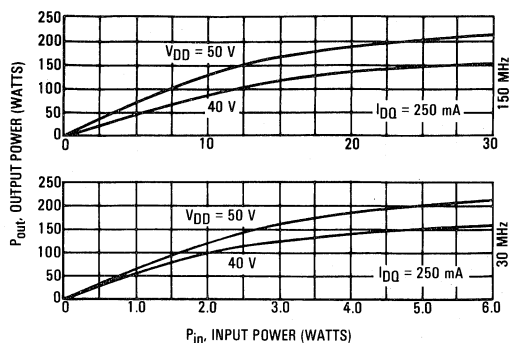
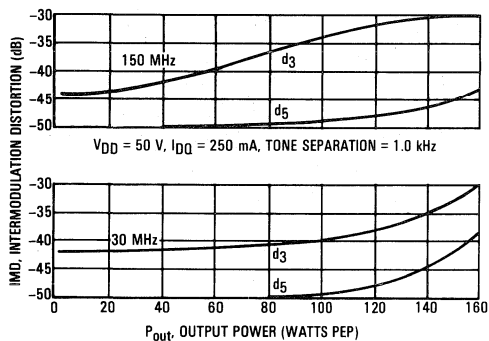
FIGURE 4 — IMD versus P_{out} 

FIGURE 5 — COMMON SOURCE UNITY GAIN FREQUENCY versus DRAIN CURRENT

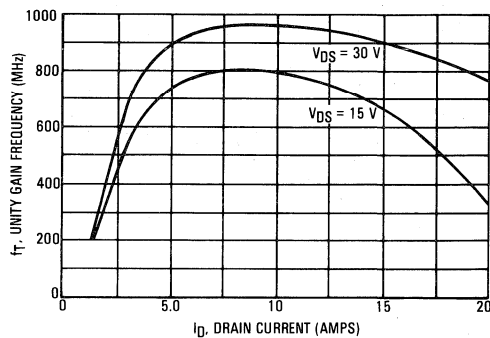
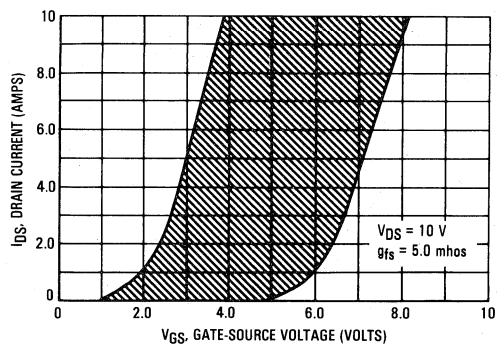


FIGURE 6 — GATE VOLTAGE versus DRAIN CURRENT



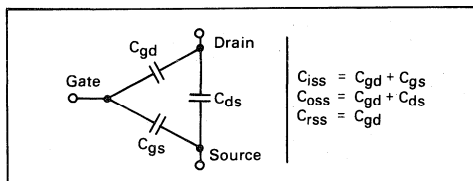
TMOS POWER FET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the TMOS FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the TMOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

Advance Information

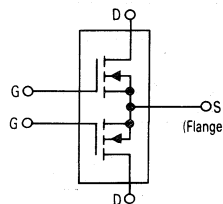
The RF TMOS Line

RF Power Field-Effect Transistor

N-Channel Enhancement-Mode TMOS

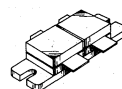
... designed for broadband commercial and military applications using push-pull circuits in the 2–175 MHz frequency band. The high power, high gain and broadband performance of each device makes possible solid-state transmitters for FM broadcast or TV channel frequency bands.

- Push-Pull Package for Broadband Circuits
- Low Thermal Resistance — 0.35°C/W Max
- Ruggedness Tested at Rated Output Power
- Nitride Passivation
- All Aluminum Metal System for High Reliability



MRF151G

300 W, 50 V, 2–175 MHz
N-CHANNEL
TMOS BROADBAND
RF POWER FETs



CASE 375-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	± 20	Vdc
Drain Current — Continuous	I_D	40	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	500 2.85	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.35	°C/W
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.			

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Each Side)					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100$ mA)	$V_{(BR)DS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 50$ Vdc, $V_{GS} = 0$)	I_{DSS}	—	—	5	mAdc
Gate-Body Leakage Current ($V_{GS} = 20$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	—	1	μAdc

This document contains information on a new product. Specifications and information herein are subject to change without notice.

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

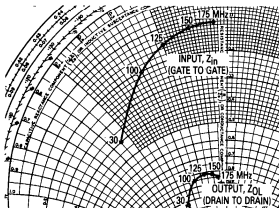
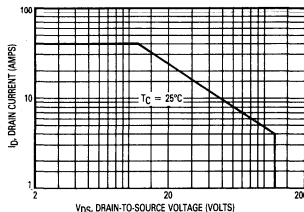
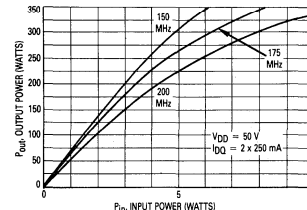
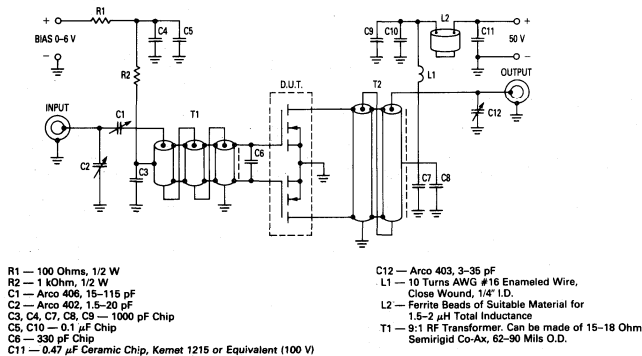
Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (Each Side)					
Gate Threshold Voltage ($V_{DS} = 10\text{ V}$, $I_D = 100\text{ mA}$)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage ($V_{GS} = 10\text{ V}$, $I_D = 10\text{ A}$)	$V_{DS(on)}$	—	—	5	Vdc
Forward Transconductance ($V_{DS} = 10\text{ V}$, $I_D = 5\text{ A}$)	g_{fs}	5	7	—	mhos

DYNAMIC CHARACTERISTICS (Each Side)

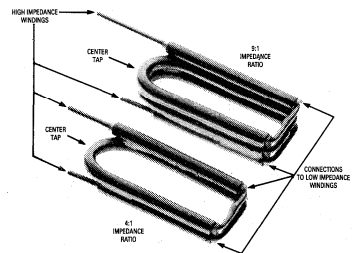
Input Capacitance ($V_{DS} = 50\text{ V}$, $V_{GS} = 0$, $f = 1\text{ MHz}$)	C_{iss}	—	350	—	pF
Output Capacitance ($V_{DS} = 50\text{ V}$, $V_{GS} = 0$, $f = 1\text{ MHz}$)	C_{oss}	—	225	—	pF
Reverse Transfer Capacitance ($V_{DS} = 50\text{ V}$, $V_{GS} = 0$, $f = 1\text{ MHz}$)	C_{rss}	—	20	—	pF

FUNCTIONAL TESTS

Common Source Amplifier Power Gain ($V_{DD} = 50\text{ V}$, $P_{out} = 300\text{ W}$, $I_{DQ} = 500\text{ mA}$, $f = 175\text{ MHz}$)	G_{ps}	—	16	—	dB
Drain Efficiency ($V_{DD} = 50\text{ V}$, $P_{out} = 300\text{ W}$, $f = 175\text{ MHz}$, $I_D(\text{Max}) = 11\text{ A}$)	η	—	55	—	%
Load Mismatch ($V_{DD} = 50\text{ V}$, $P_{out} = 300\text{ W}$, $I_{DQ} = 500\text{ mA}$, VSWR 5:1 at all Phase Angles)	ψ	No Degradation in Output Power			

**Figure 1. Input and Output Impedance****Figure 2. DC Safe Operating Area****Figure 3. Output Power versus Input Power**

Unless Otherwise Noted, All Chip Capacitors are ATC Type 100 or Equivalent.

Figure 4. 175 MHz Test Circuit

T2 — 1:4 RF Transformer. Can be made of 25–35 Ohm Semirigid Co-Ax, 90–100 Mils O.D.

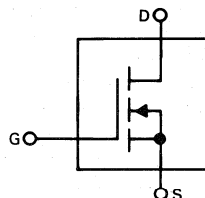
NOTE: For stability, the input transformer T1 must be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz. The same is required for the output transformer.

See pictures for construction details.

The RF TMOS Line
Power Field Effect Transistor
N-Channel Enhancement-Mode

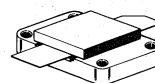
... designed primarily for linear large-signal output stages in the 2–100 MHz frequency range.

- Specified 50 Volts, 30 MHz Characteristics
 - Output Power = 300 Watts
 - Power Gain = 17 dB (Typ)
 - Efficiency = 45% (Typ)



MRF153

**TMOS LINEAR
 RF POWER FETs
 300 WATTS
 2–100 MHz**



CASE 368-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	40	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	700 4	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to $+150$	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.25	$^\circ\text{C}/\text{W}$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100$ mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 50$ V, $V_{GS} = 0$)	I_{DSS}	—	—	10	mA _{dc}
Gate-Body Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	—	3	μA_{dc}

ON CHARACTERISTICS

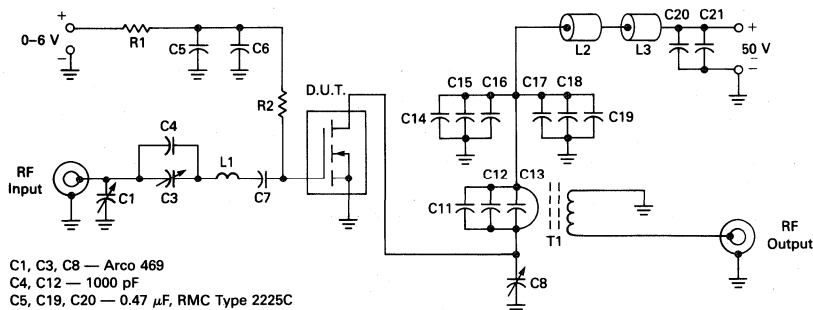
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 100$ mA)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage ($V_{GS} = 10$ V, $I_D = 20$ A)	$V_{DS(on)}$	—	—	5	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 10$ A)	g_{fs}	8	10	—	mhos

DYNAMIC CHARACTERISTICS

Input Capacitance ($V_{DS} = 50$ V, $V_{GS} = 0$ V, $f = 1$ MHz)	C_{iss}	—	800	—	pF
Output Capacitance ($V_{DS} = 50$ V, $V_{GS} = 0$, $f = 1$ MHz)	C_{oss}	—	500	—	pF
Reverse Transfer Capacitance ($V_{DS} = 50$ V, $V_{GS} = 0$, $f = 1$ MHz)	C_{rss}	—	100	—	pF

FUNCTIONAL TESTS

Common Source Amplifier Power Gain ($V_{DD} = 50$ V, $P_{out} = 300$ W, $I_{DQ} = 400$ mA)	G_{ps}	—	17	—	dB
Drain Efficiency ($V_{DD} = 50$ V, $P_{out} = 300$ W, $f = 30$ MHz)	η	—	45	—	%
Intermodulation Distortion ($V_{DD} = 50$ V, $P_{out} = 300$ W (PEP), $f_1 = 30$ MHz, $f_2 = 30.001$ MHz, $I_{DQ} = 40$ mA)	IMD(d3)	—	-25	—	dB



C1, C3, C8 — Arco 469
 C4, C12 — 1000 pF
 C5, C19, C20 — 0.47 μF , RMC Type 2225C
 C6, C7, C14, C15, C16 — 0.1 μF
 C11 — 470 pF
 C13 — Two Unencapsulated 1000 pF Mica, in Series
 C17, C18 — 0.039 μF
 C21 — 10 μF /100 V Electrolytic
 R1, R2 — 10 Ohms/2W Carbon
 L1 — 2 Turns #16 AWG, 1/2" ID, 1/4" Long

L2, L3 — Ferrite Beads, Fair-Rite Products Corp. #2673000801
 T1 — RF Transformer, 1:16 Impedance Ratio. See Motorola
 Application Note AN-749, Figure 4 for details.
 Ferrite Material: 2 Each, Fair-Rite Products Corp. #2667540001

All capacitors ATC type 100/200 chips or equivalent unless otherwise noted.

Figure 1. 30 MHz Test Circuit

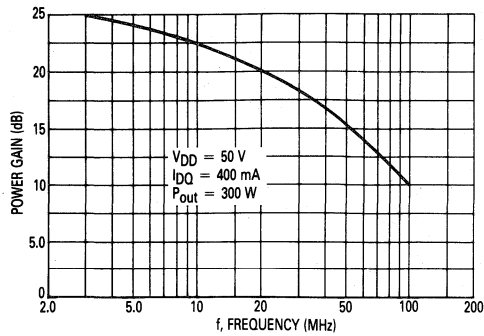


Figure 2. Power Gain versus Frequency

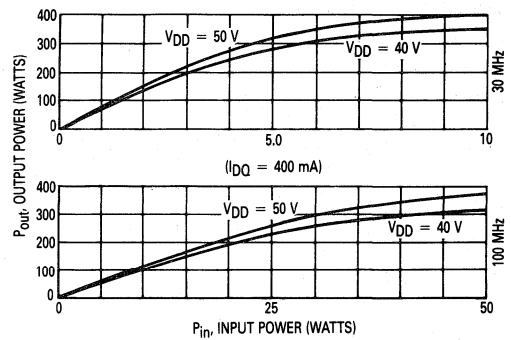


Figure 3. Output Power versus Input Power

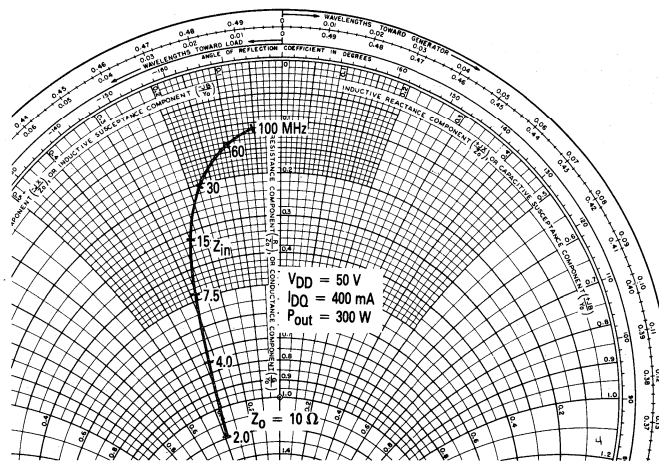
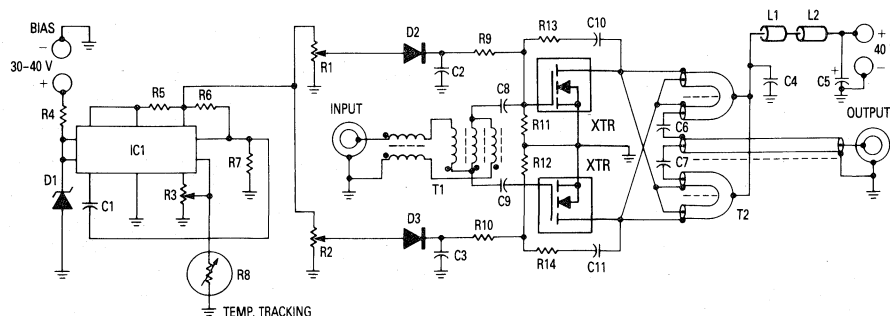


Figure 4. Series Equivalent Impedance



C1 — 1000 pF Ceramic
 C2, C3, C4, C8, C9, C10, C11 — 0.1 μ F Ceramic
 C5 — 10 μ F/100 V Electrolytic
 C6, C7 — 0.1 μ F Ceramic, (ATC 200/823 or Equivalent)
 D1 — 28 V Zener, 1N5362 or Equivalent
 D3 — 1N4148
 IC1 — MC1723
 L1, L2 — Fair-Rite Products Corp. Ferrite Beads #2673000801
 R1, R2, R3 — 10 k Trimpot
 R4 — 1.0 k / 1.0 W
 R5 — 10 Ohms
 R6 — 2.0 k

R7 — 10 k
 R8 — Thermistor, 10 k (25°C), 2.5 k (75°C)
 R9, R10 — 100 Ohms
 R11, R12 — 1.0 k
 R13, R14 — 50–100 Ohms, 4 x 2 W Carbon in Parallel
 T1 — 9:1 Transformer, Trifilar and Balun Wound on Separate Fair-Rite Products Corp. Balun Cores #286100012, 5 Turns Each.
 T2 — 1:9 Transformer, Balun 50 Ohm CO-AX Cable RG-188, Low Impedance Lines W.L. Gore 16 Ohms CO-AX Type CXN 1837. Each Winding Threaded Through Two Fair-Rite Products Corp. #2661540001 Ferrite Sleeves (6 Each).
 XTR — MRF153

Figure 5. 20–80 MHz 500 W Broadband Amplifier

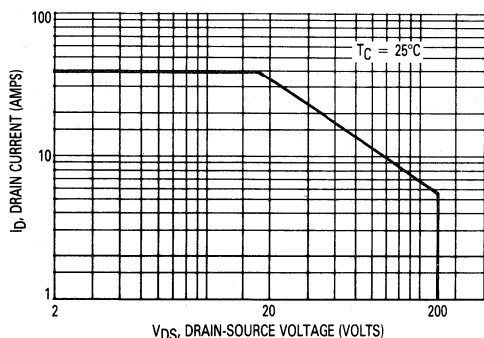


Figure 6. DC Safe Operating Area

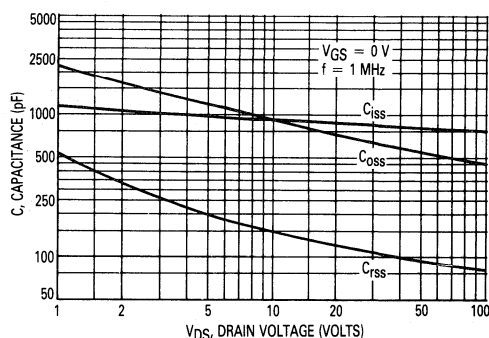


Figure 7. Capacitance versus Drain Voltage

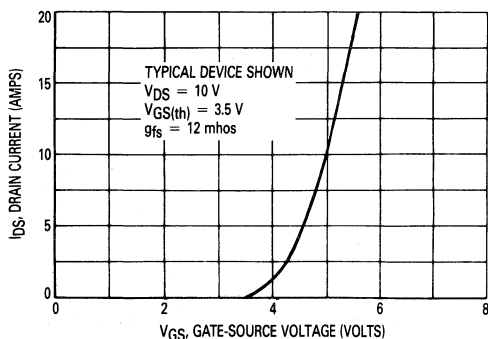


Figure 8. Gate Voltage versus Drain Current

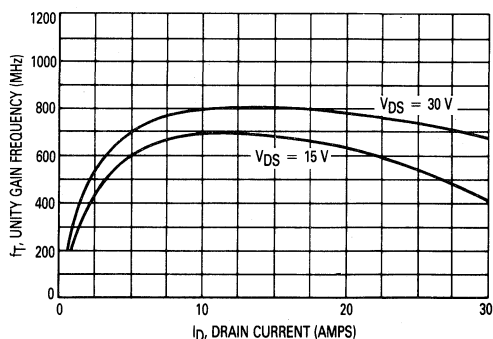


Figure 9. Common Source Unity Gain Frequency versus Drain Current

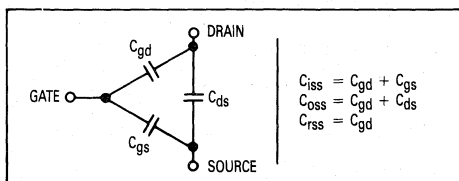
TMOS POWER FET CONSIDERATIONS

MOSFET CAPACITANCES

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These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the interterminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the TMOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. The addition of an internal zener diode may result in detrimental effects on the reliability of a power MOSFET. If gate protection is required, an external zener diode is recommended.

MOUNTING OF HIGH POWER RF POWER TRANSISTORS

The package of this device is designed for conduction cooling. It is extremely important to minimize the thermal resistance between the device flange and the heat dissipator.

Since the device mounting flange is made of soft copper, it may be deformed during various stages of handling or during transportation. It is recommended that the user makes a final inspection on this before the device installation. ± 0.0005 " is considered sufficient for the flange bottom.

The same applies to the heat dissipator in the device mounting area. If copper heatsink is not used, a copper head spreader is strongly recommended between the device mounting surfaces and the main heatsink. It should be at least 1/4" thick and extend at least one inch from the flange edges. A thin layer of thermal compound in all interfaces is, of course, essential. The recommended torque on the 4-40 mounting screws should be in the area of 4-5 lbs.-inch, and spring type lock washers along with flat washers are recommended.

For die temperature calculations, the Δ temperature from a corner mounting screw area to the bottom center of the flange is approximately 5°C and 10°C under normal operating conditions (dissipation 150 W and 300 W respectively).

The main heat dissipator must be sufficiently large and have low R_{θ} for moderate air velocity, unless liquid cooling is employed.

CIRCUIT CONSIDERATIONS

At high power levels (500 W and up), the circuit layout becomes critical due to the low impedance levels and high RF currents associated with the output matching. Some of the components, such as capacitors and inductors must also withstand these currents. The component losses are directly proportional to the operating fre-

MRF153

quency. The manufacturers specifications on capacitor ratings should be consulted on these aspects prior to design.

Push-pull circuits are less critical in general, since the ground referenced RF loops are practically eliminated,

and the impedance levels are higher for a given power output. High power broadband transformers are also easier to design than comparable LC matching networks.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	.....	Drain
Emitter	.....	Source
Base	.....	Gate
$V_{(BR)CES}$	.....	$V_{(BR)DSS}$
V_{CBO}	.....	V_{DGO}
I_C	.....	I_D
I_{CES}	.....	I_{DSS}
I_{EBO}	.....	I_{GSS}
$V_{BE(on)}$	.....	$V_{GS(th)}$
$V_{CE(sat)}$	.....	$V_{DS(on)}$
C_{ib}	.....	C_{iss}
C_{ob}	.....	C_{oss}
h_{fe}	.....	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	.....	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

The RF TMOS Line
Power Field Effect Transistor
N-Channel Enhancement-Mode

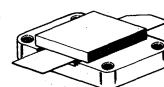
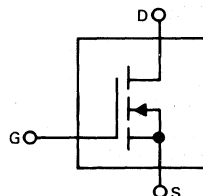
... designed primarily for linear large-signal output stages in the 2–100 MHz frequency range.

- Specified 50 Volts, 30 MHz Characteristics
 - Output Power = 600 Watts
 - Power Gain = 17 dB (Typ)
 - Efficiency = 45% (Typ)



MRF154

TMOS LINEAR
RF POWER FET
600 WATTS
2–100 MHz



CASE 368-01, STYLE 2
(HOG PAC)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	125	Vdc
Drain-Gate Voltage	V_{DG}	125	Vdc
Gate-Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	60	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	1350 7.7	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to $+150$	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

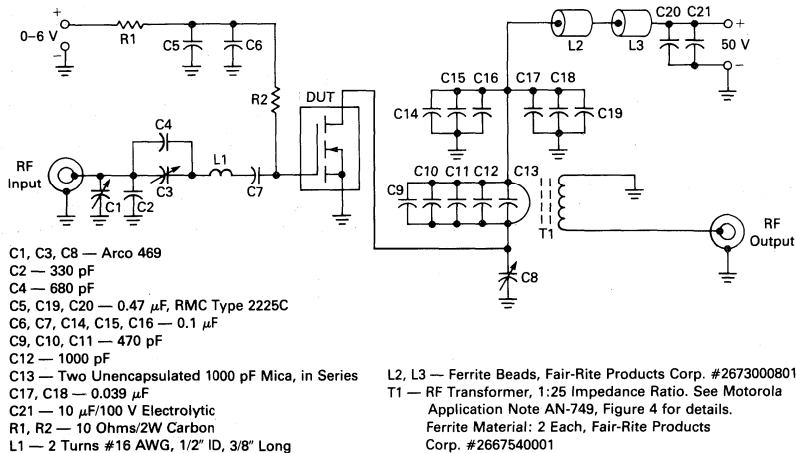
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.13	$^\circ\text{C/W}$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100$ mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 50$ V, $V_{GS} = 0$)	I_{DSS}	—	—	20	mA _{dc}
Gate-Body Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	—	5	μA_{dc}
ON CHARACTERISTICS					
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 100$ mA)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage ($V_{GS} = 10$ V, $I_D = 40$ A)	$V_{DS(on)}$	—	—	5	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 20$ A)	g_{fs}	16	20	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance ($V_{DS} = 50$ V, $V_{GS} = 0$ V, $f = 1$ MHz)	C_{iss}	—	1600	—	pF
Output Capacitance ($V_{DS} = 50$ V, $V_{GS} = 0$, $f = 1$ MHz)	C_{oss}	—	1000	—	pF
Reverse Transfer Capacitance ($V_{DS} = 50$ V, $V_{GS} = 0$, $f = 1$ MHz)	C_{rss}	—	200	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain ($V_{DD} = 50$ V, $P_{out} = 600$ W, $I_{DQ} = 800$ mA, $f = 30$ MHz)	G_{ps}	—	17	—	dB
Drain Efficiency ($V_{DD} = 50$ V, $P_{out} = 600$ W, $I_{DQ} = 800$ mA, $f = 30$ MHz)	η	—	45	—	%
Intermodulation Distortion ($V_{DD} = 50$ V, $P_{out} = 600$ W(PEP), $f_1 = 30$ MHz, $f_2 = 30.001$ MHz, $I_{DQ} = 800$ mA)	IMD(d3)	—	-25	—	dB



All capacitors ATC type 100/200 chips or equivalent unless otherwise noted.

FIGURE 1 — 30 MHz TEST CIRCUIT

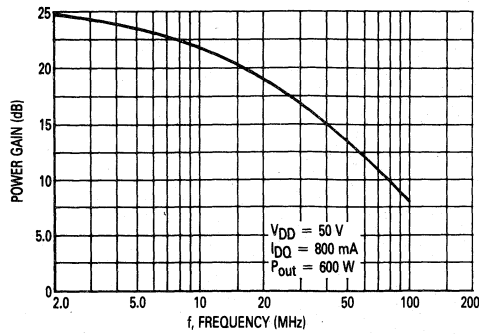


Figure 2. Power Gain versus Frequency

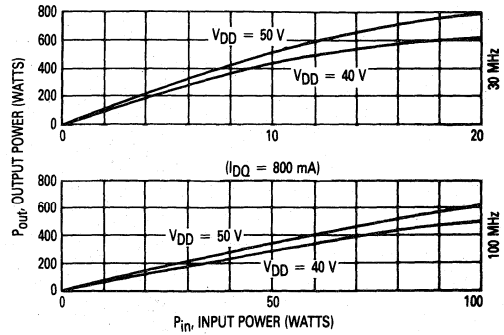


Figure 3. Output Power versus Input Power

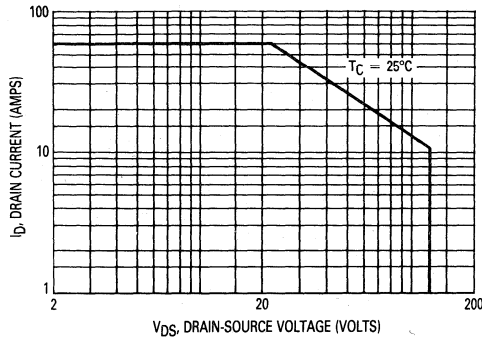


Figure 4. DC Safe Operating Area

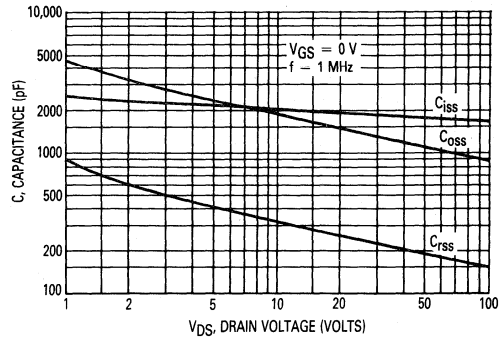


Figure 5. Capacitance versus Drain Voltage

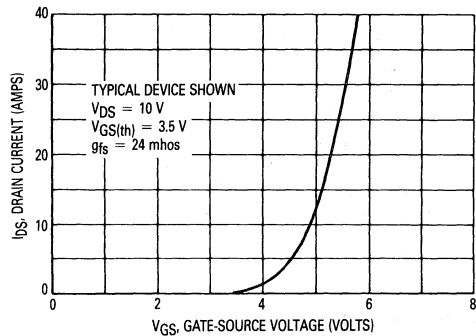


Figure 6. Gate Voltage versus Drain Current

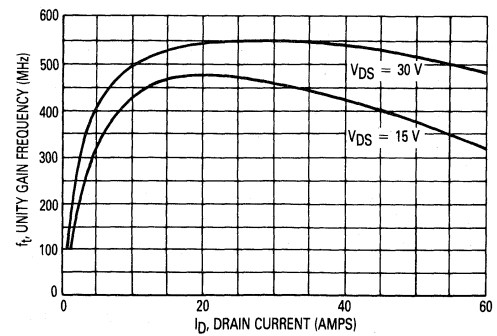


Figure 7. Common Source Unity Gain Frequency versus Drain Current

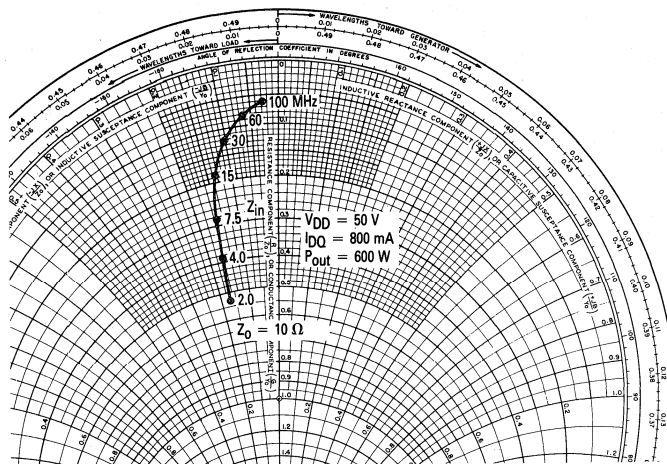
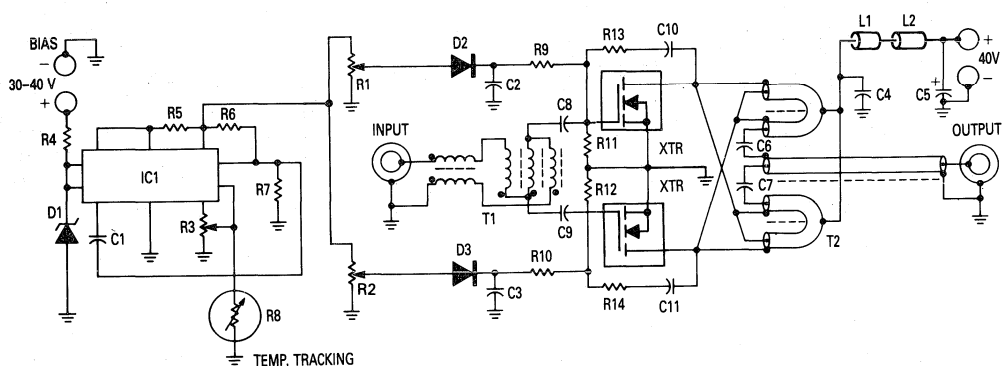


Figure 8. Series Equivalent Impedance



C1 — 1000 pF Ceramic
 C2, C3, C4, C8, C9, C10, C11 — 0.1 μ F Ceramic
 C5 — 10 μ F/100 V Electrolytic
 C6, C7 — 0.1 μ F Ceramic, (ATC 200/823 or Equivalent)
 D1 — 28 V Zener, 1N5362 or Equivalent
 D3 — 1N4148
 IC1 — MC1723
 L1, L2 — Fair-Rite Products Corp. Ferrite Beads #2673000801
 R1, R2, R3 — 10 k Trimpot
 R4 — 1.0 k / 1.0 W
 R5 — 10 Ohms
 R6 — 2.0 k

R7 — 10 k
 R8 — Thermistor, 10 k (25°C), 2.5 k (75°C)
 R9, R10 — 100 Ohms
 R11, R12 — 1.0 k
 R13, R14 — 50–100 Ohms, 4 x 2 W Carbon in Parallel
 T1 — 9:1 Transformer, Trifilar and Balun Wound on Separate
 Fair-Rite Products Corp. Balun Cores #286100012, 5 Turns Each.
 T2 — 1:9 Transformer, Balun 50 Ohm CO-AX Cable RG-188,
 Low Impedance Lines W.L. Gore 16 Ohms CO-AX Type CXN
 1837.
 Each Winding Threaded Through Two Fair-Rite Products Corp.
 #2661540001 Ferrite Sleeves (6 Each).
 XTR — MRF154

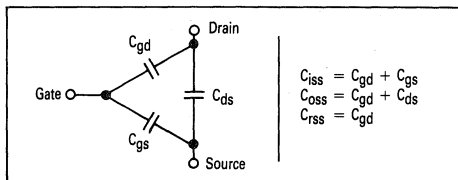
Figure 9. 20–80 MHz 1 kW Broadband Amplifier

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitances between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the TMOS FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the interterminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the TMOS FET is a polysilicon material, and is electrically isolated from the source by a layer of

oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. The addition of an internal zener diode may result in detrimental effects on the reliability of a power MOSFET. If gate protection is required, an external zener diode is recommended.

MOUNTING OF HIGH POWER RF POWER TRANSISTORS

The package of this device is designed for conduction cooling. It is extremely important to minimize the thermal resistance between the device flange and the heat dissipator.

Since the device mounting flange is made of soft copper, it may be deformed during various stages of handling or during transportation. It is recommended that the user makes a final inspection on this before the device installation. $\pm 0.0005''$ is considered sufficient for the flange bottom.

The same applies to the heat dissipator in the device mounting area. If copper heatsink is not used, a copper head spreader is strongly recommended between the device mounting surfaces and the main heatsink. It should be at least $1/4''$ thick and extend at least one inch from the flange edges. A thin layer of thermal compound in all interfaces is, of course, essential. The recommended torque on the 4-40 mounting screws should be in the area of 4-5 lbs.-inch, and spring type lock washers along with flat washers are recommended.

For die temperature calculations, the Δ temperature from a corner mounting screw area to the bottom center of the flange is approximately 5°C and 10°C under normal operating conditions (dissipation 150 W and 300 W respectively).

The main heat dissipator must be sufficiently large and have low R_θ for moderate air velocity, unless liquid cooling is employed.

CIRCUIT CONSIDERATIONS

At high power levels (500 W and up), the circuit layout becomes critical due to the low impedance levels and high RF currents associated with the output matching. Some of the components, such as capacitors and inductors must also withstand these currents. The component losses are directly proportional to the operating frequency. The manufacturers specifications on capacitor

ratings should be consulted on these aspects prior to design.

Push-pull circuits are less critical in general, since the ground referenced RF loops are practically eliminated, and the impedance levels are higher for a given power output. High power broadband transformers are also easier to design than comparable LC matching networks.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	.....	Drain
Emitter	.....	Source
Base	.....	Gate
$V_{(BR)CES}$	.....	$V_{(BR)DSS}$
V_{CBO}	.....	V_{DGO}
I_C	.....	I_D
I_{CES}	.....	I_{DSS}
I_{EBO}	.....	I_{GSS}
$V_{BE(on)}$	.....	$V_{GS(th)}$
$V_{CE(sat)}$	.....	$V_{DS(on)}$
C_{ib}	.....	C_{iss}
C_{ob}	.....	C_{oss}
h_{fe}	.....	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$		$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

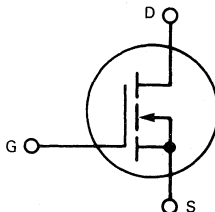
MRF161

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
 TMOS RF POWER FIELD-EFFECT TRANSISTOR**

... designed for wideband large-signal amplifier and oscillator applications in the 2.0 to 400 MHz range.

- Guaranteed 28 Volt, 400 MHz Performance
 Output Power = 5.0 Watts
 Minimum Gain = 11 dB
 Efficiency = 50% (Typical)
- Small-Signal and Large-Signal Characterization
- 100% Tested for Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 3.0 dB (Typ) at 100 mA, 400 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage ($R_{GS} = 1.0 \text{ M}\Omega$)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	0.9	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	17.5 0.10	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

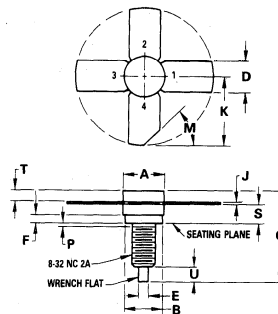
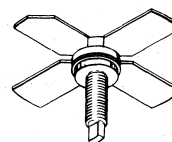
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	$^\circ\text{C/W}$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

5.0 W 2.0–400 MHz

**N-CHANNEL TMOS
 BROADBAND RF POWER**

FET



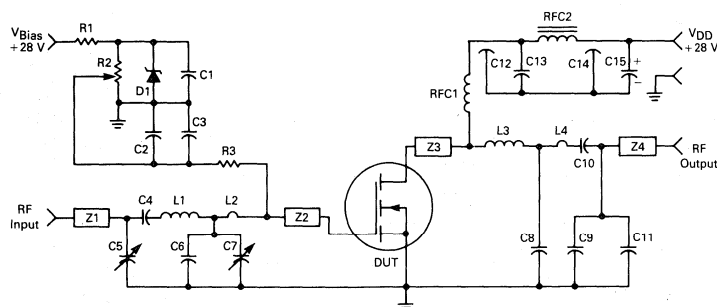
STYLE 3:
 PIN 1. SOURCE
 2. GATE
 3. SOURCE
 4. DRAIN

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 5.0$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	1.0	mA _{dc}
Gate-Source Leakage Current ($V_{GS} = 40$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μA_{dc}
ON CHARACTERISTICS					
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 10$ mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 100$ mA)	g_{fs}	80	110	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	7.0	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	9.7	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	2.3	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure ($V_{DS} = 28$ Vdc, $I_D = 100$ mA, $f = 400$ MHz, $Z_S = 67.6 + j14.1$, $Z_L = 14.5 + j25.7$)	NF	—	3.0	—	dB
Common Source Power Gain ($V_{DD} = 28$ Vdc, $P_{out} = 5.0$ W, $f = 400$ MHz, $I_{DQ} = 50$ mA)	G_{ps}	11	13.5	—	dB
Drain Efficiency ($V_{DD} = 28$ Vdc, $P_{out} = 5.0$ W, $f = 400$ MHz, $I_{DQ} = 50$ mA)	η	45	50	—	%
Electrical Ruggedness ($V_{DD} = 28$ Vdc, $P_{out} = 5.0$ W, $f = 400$ MHz, $I_{DQ} = 50$ mA, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT

C1, C2, C13 — 0.1 μF , 50 V Disc Ceramic
 C3 — 0.01 μF , 100 V Disc Ceramic
 C4, C10 — 220 pF, 100 Mil Chip Cap
 C5 — 1–10 pF Johanson or Equivalent
 C6 — 5.0 pF Mini-Unileco or Equivalent
 C7 — 1–20 pF Johanson or Equivalent
 C8 — 15 pF, 100 Mil ATC Chip Cap or Equivalent
 C9, C11 — 2.2, 100 Mil ATC Chip Cap or Equivalent
 C12, C14 — 680 pF Feedthru
 C15 — 50 μF , 35 V
 R1 — 1.6 k Ω , 1/4 W
 R2 — 10 Turns 10 k Ω
 R3 — 10 k, 1/2 W
 D1 — 1N5347B Motorola Zener or Equivalent

L1 — 1-3/4 Turns, 0.185" ID 0.08" Long #20 AWG Enamel — (25 nH)
 L2 — #20 AWG Enamel, Hairpin $\frac{1}{4}$ 0.353" — (10.5 nH)
 $\rightarrow \leftarrow$ 0.185"

L3 — 1-3/4 Turns, 0.128" ID 0.11" Long #18 AWG Enamel — (15 nH)
 L4 — #18 AWG Enamel, Hairpin $\frac{1}{4}$ 0.410" — (12.5 nH)
 $\rightarrow \leftarrow$ 0.185"

RFC1 — 10 Turns, 0.300" ID #20 AWG Enamel Closewound
 RFC2 — Ferroxcube VK-200
 Z1 — 0.82" x 0.164" Microstrip — ($Z_0 = 50 \Omega$)
 Z2, Z3 — 0.60" x 0.25" Microstrip
 Z4 — 0.76" x 0.164" Microstrip — ($Z_0 = 50 \Omega$)
 Board—Glass Teflon, 62 Mils, $\epsilon_r = 2.56$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

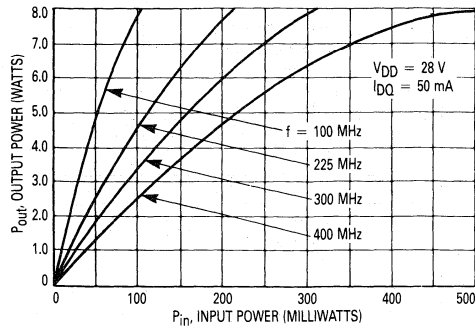


FIGURE 3 — OUTPUT POWER versus INPUT POWER

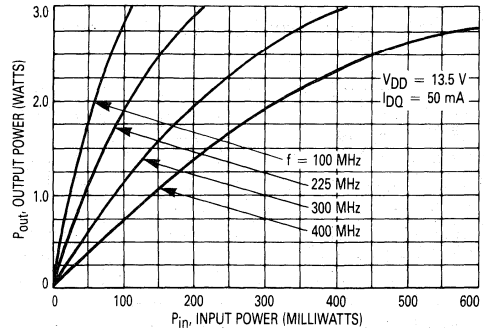
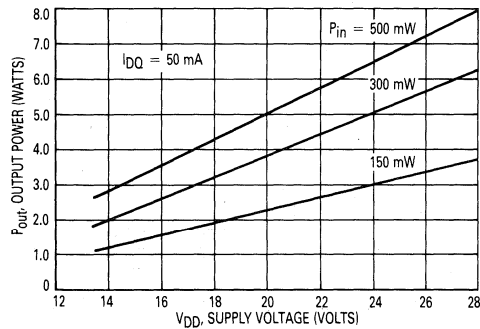
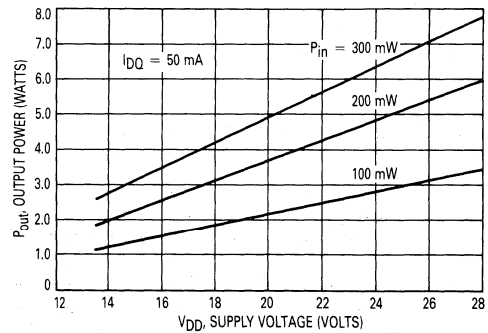
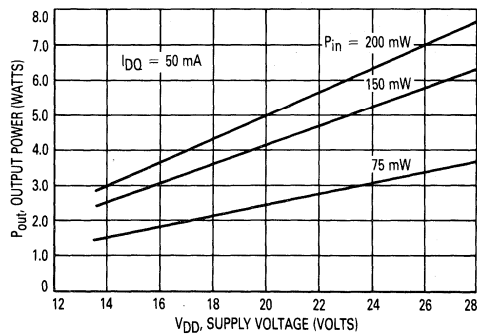
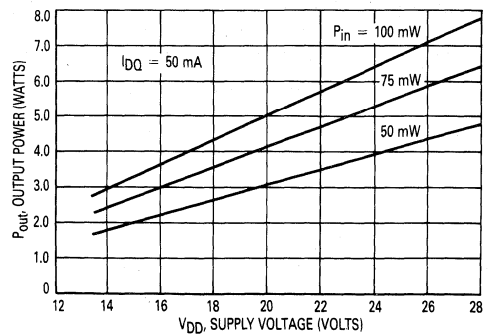
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 400\text{ MHz}$ FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 300\text{ MHz}$ FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 225\text{ MHz}$ FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 100\text{ MHz}$ 

FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

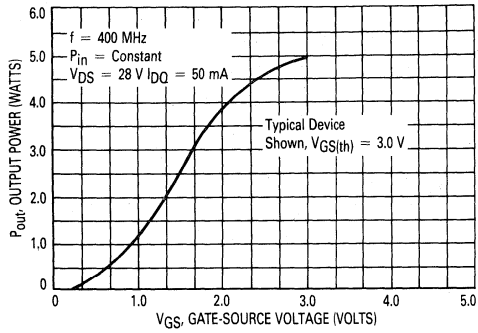
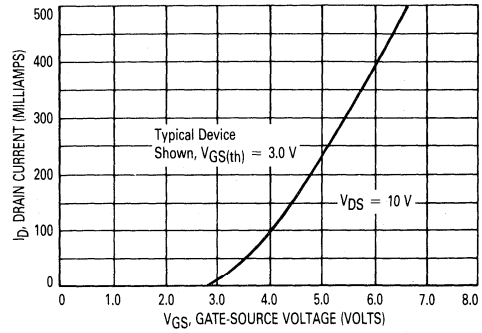
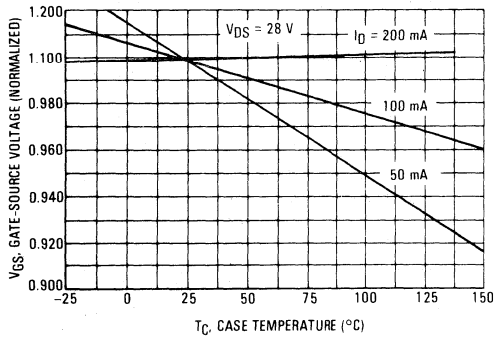
FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE
(TRANSFER CHARACTERISTICS)FIGURE 10 — GATE-SOURCE VOLTAGE versus
CASE TEMPERATURE

FIGURE 11 — CAPACITANCE versus VOLTAGE

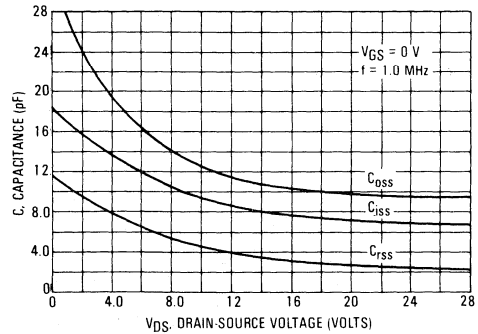


FIGURE 12 — MAXIMUM RATED FORWARD BIASED
SAFE OPERATING AREA

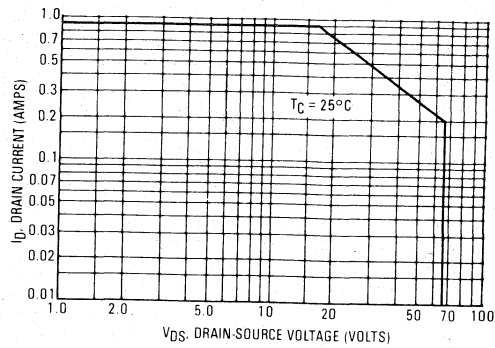


FIGURE 13 — LARGE-SIGNAL SERIES EQUIVALENT INPUT AND
OUTPUT IMPEDANCE, Z_{in} , Z_{OL}^*

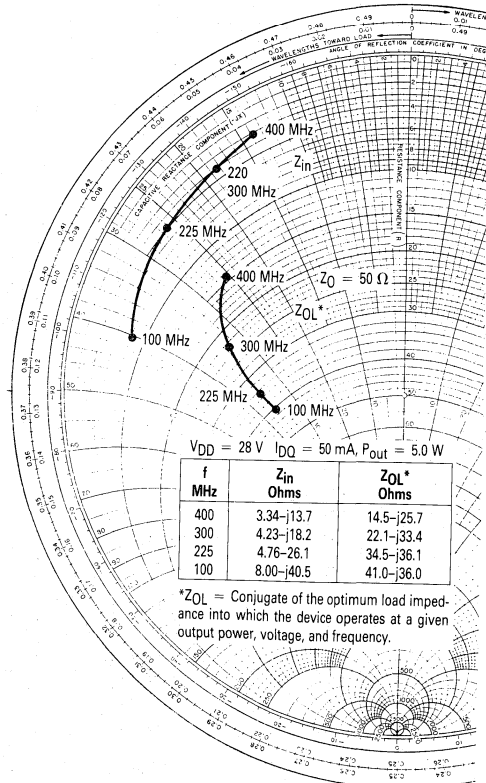
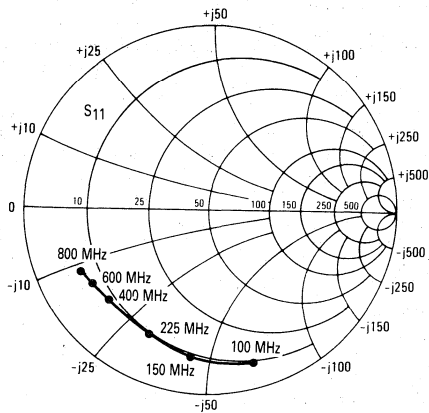


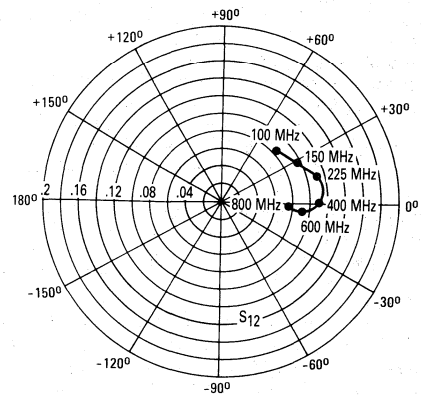
FIGURE 14 — COMMON SOURCE SCATTERING PARAMETERS
50 OHM SYSTEM
 $V_{DS} = 28 \text{ V}$, $I_D = 250 \text{ mA}$

f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	|S ₁₁|	∠ φ	|S ₂₁|	∠ φ	|S ₁₂|	∠ φ	|S ₂₂|	∠ φ
2.0	1.000	-1.69	13.64	178	0.002	62	0.947	-1.84
5.0	1.000	-4.63	13.60	176	0.005	69	0.945	-4.00
10	0.997	-8.95	13.70	173	0.010	80	0.941	-7.92
20	0.989	-17.49	13.36	167	0.022	73	0.929	-15.8
30	0.977	-26	13.07	162	0.032	71	0.915	-23
40	0.968	-34	12.76	156	0.042	67	0.902	-30
50	0.949	-42	12.31	151	0.050	61	0.885	-37
60	0.930	-49	11.88	146	0.058	57	0.866	-43
70	0.913	-56	11.45	141	0.066	53	0.846	-49
80	0.897	-62	10.96	137	0.072	50	0.831	-55
90	0.885	-68	10.50	133	0.078	46	0.817	-60
100	0.867	-74	10.00	129	0.081	43	0.800	-65
110	0.853	-78	9.54	125	0.085	40	0.787	-69
120	0.838	-84	8.92	122	0.090	37	0.775	-74
130	0.819	-88	8.75	119	0.093	35	0.762	-78
140	0.812	-92	8.30	116	0.096	31	0.755	-81
150	0.800	-96	7.95	113	0.098	28	0.742	-86
160	0.785	-99	7.54	111	0.100	26	0.735	-89
170	0.775	-103	7.25	109	0.102	24	0.728	-93
180	0.765	-105	6.85	106	0.103	23	0.725	-96
190	0.755	-108	6.60	104	0.104	21	0.720	-98
200	0.740	-111	6.20	100	0.106	18	0.719	-99
225	0.735	-116	5.71	96	0.110	16	0.715	-103
250	0.723	-121	5.17	92	0.112	12	0.708	-107
275	0.720	-124	4.80	89	0.113	10	0.706	-110
300	0.716	-128	4.43	85	0.112	7.0	0.706	-113
325	0.715	-130	4.17	83	0.111	4.0	0.717	-115
350	0.715	-133	3.87	79	0.111	3.0	0.720	-117
375	0.715	-135	3.67	76	0.111	1.0	0.728	-118
400	0.711	-137	3.43	74	0.109	0	0.729	-119
425	0.714	-139	3.25	71	0.104	0	0.738	-120
450	0.717	-140	3.11	69	0.104	-2.0	0.743	-121
475	0.719	-141	2.95	67	0.103	-3.0	0.757	-122
500	0.722	-142	2.81	65	0.102	-4.0	0.770	-122
525	0.723	-144	2.69	62	0.099	-6.0	0.777	-123
550	0.727	-144	2.55	61	0.097	-6.0	0.787	-123
575	0.729	-145	2.46	59	0.097	-7.0	0.802	-124
600	0.733	-146	2.37	57	0.094	-7.0	0.814	-124
625	0.734	-147	2.29	55	0.090	-8.0	0.824	-126
650	0.740	-148	2.19	54	0.087	-8.0	0.830	-127
675	0.749	-149	2.12	53	0.085	-6.0	0.849	-127
700	0.758	-149	2.07	51	0.084	-6.0	0.879	-127
725	0.761	-150	1.99	49	0.082	-5.0	0.886	-127
750	0.763	-151	1.93	48	0.081	-4.0	0.905	-127
775	0.765	-151	1.90	48	0.079	-3.0	0.919	-128
800	0.770	-152	1.83	46	0.076	-1.0	0.921	-128

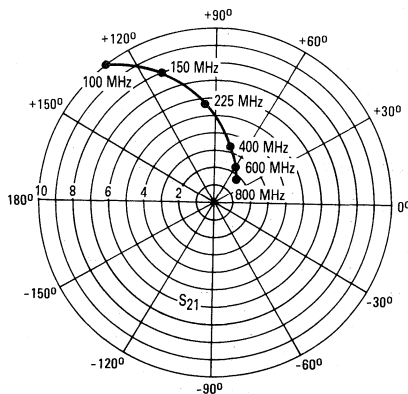
**FIGURE 15 — S_{11} , INPUT REFLECTION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$, $I_D = 250 \text{ mA}$



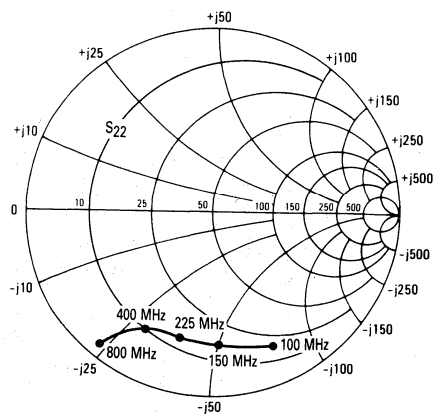
**FIGURE 16 — S_{12} , REVERSE TRANSMISSION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$, $I_D = 250 \text{ mA}$



**FIGURE 17 — S_{21} , FORWARD TRANSMISSION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$, $I_D = 250 \text{ mA}$



**FIGURE 18 — S_{22} , OUTPUT REFLECTION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$, $I_D = 250 \text{ mA}$



DESIGN CONSIDERATIONS

The MRF161 is a TMOS RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola TMOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of TMOS RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF161 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF161 was characterized at $I_{DQ} = 50$ mA, which is the suggested minimum value of I_{DQ} . For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a

simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

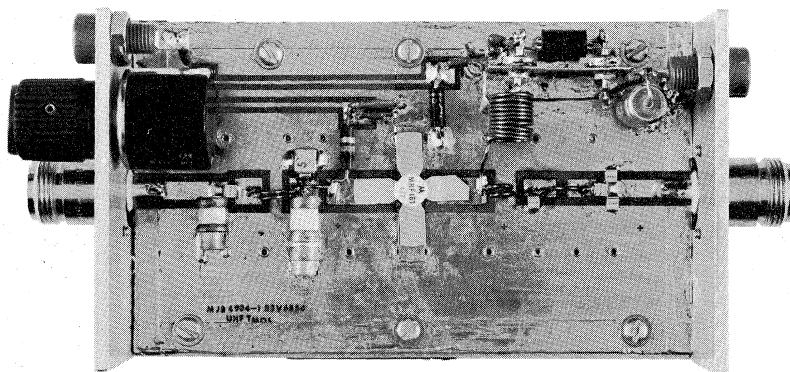
Power output of the MRF161 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC, and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for the MRF161. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of TMOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of TMOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF161, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF161 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A for a discussion of two port network theory and stability.

FIGURE 19 — 400 MHz TEST CIRCUIT



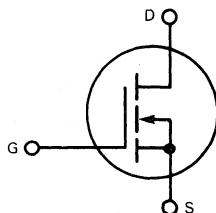
MRF162

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
TMOS RF POWER FIELD-EFFECT TRANSISTOR**

... designed for wideband large-signal output and driver applications in the 2.0 to 400 MHz range.

- Guaranteed 28 Volt, 400 MHz Performance
Output Power = 15 Watts
Minimum Gain = 11 dB
Efficiency = 50% (Typical)
- Small-Signal and Large-Signal Characterization
- 100% Tested for Load Mismatch At All Phase Angles
With 30:1 VSWR
- Low Noise Figure — 2.0 dB (Typ) at 300 mA, 400 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage ($R_{GS} = 1.0 \text{ M}\Omega$)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	2.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 0.286	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

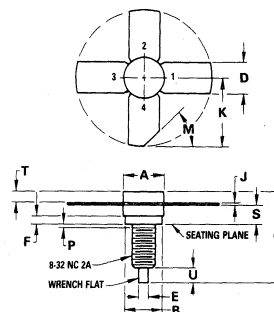
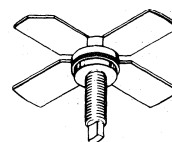
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.5	$^\circ\text{C}/\text{W}$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

15 W 2.0-400 MHz

**N-CHANNEL TMOS
BROADBAND RF POWER**

FET



STYLE 3:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM	—	45° NOM	—
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.82	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 5.0$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	2.0	mAdc
Gate-Source Leakage Current ($V_{GS} = 40$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μAdc

ON CHARACTERISTICS

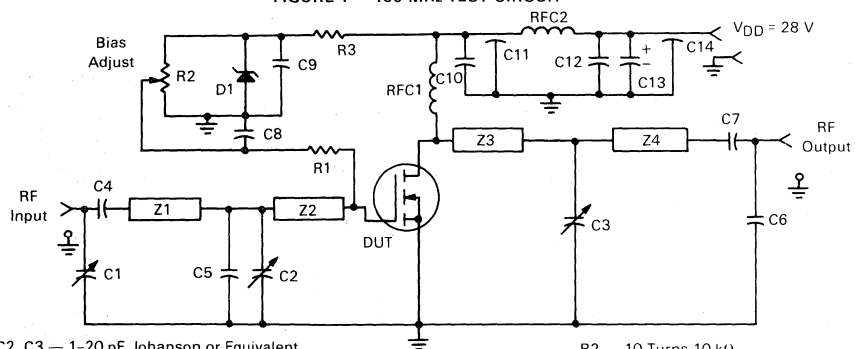
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 25$ mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 250$ mA)	g_{fs}	250	400	—	mmhos

DYNAMIC CHARACTERISTICS

Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	24	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	27	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	5.5	—	pF

FUNCTIONAL CHARACTERISTICS (Figure 1)

Noise Figure ($V_{DS} = 28$ Vdc, $I_D = 300$ mA, $f = 400$ MHz, $Z_S = 5.9 + j7.8 \Omega$, $Z_L = 3.78 + j5.75 \Omega$)	NF	—	2.0	—	dB
Common Source Power Gain ($V_{DD} = 28$ Vdc, $P_{out} = 15$ W, $f = 400$ MHz, $I_{DQ} = 50$ mA)	G_{ps}	11	13.6	—	dB
Drain Efficiency ($V_{DD} = 28$ Vdc, $P_{out} = 15$ W, $f = 400$ MHz, $I_{DQ} = 50$ mA)	η	45	50	—	%
Electrical Ruggedness ($V_{DD} = 28$ Vdc, $P_{out} = 15$ W, $f = 400$ MHz, $I_{DQ} = 50$ mA, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT

C1, C2, C3 — 1–20 pF Johanson or Equivalent
 C4, C7 — 270 pF, 100 Mil Chip Cap
 C5 — 18 pF Mini-Unleco or Equivalent
 C6 — 12 pF, 100 Mil Chip Cap
 C8 — 0.01 μF , 50 V Disc Ceramic
 C9, C10, C12 — 0.1 μF , 50 V Disc Ceramic
 C11, C14 — 680 pF Feedthru
 C13 — 20 μF , 50 V
 D1 — 1N5925A Motorola Zener
 R1 — 10 k Ω , 1/4 W

R2 — 10 Turns 10 k Ω
 R3 — 1.6 k Ω , 1/4 W
 RFC1 — 10 Turns, 0.300" ID #20 AWG
 Enamel Closewound
 RFC2 — Ferroxcube VK-200 — 19/4B
 Z1 — 1.5" \times 0.250" Microstrip
 Z2 — 0.6" \times 0.250" Microstrip
 Z3 — 1.3" \times 0.250" Microstrip
 Z4 — 0.85" \times 0.250" Microstrip
 Board — Glass Teflon, 62 Mils, $\epsilon_r = 2.56$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

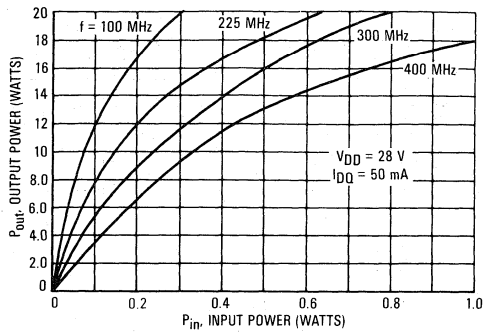


FIGURE 3 — OUTPUT POWER versus INPUT POWER

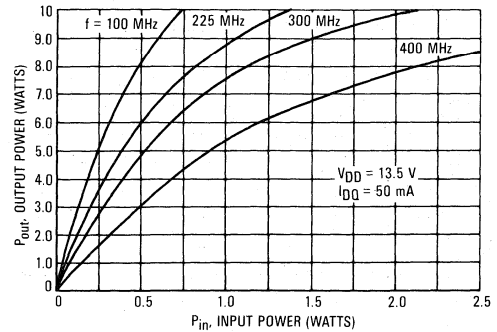
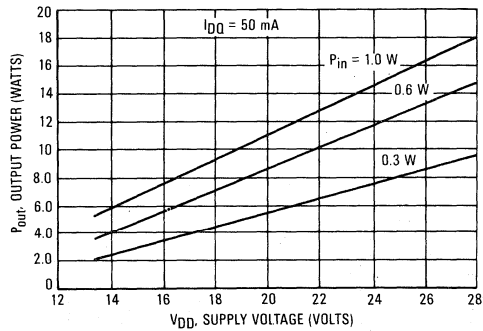
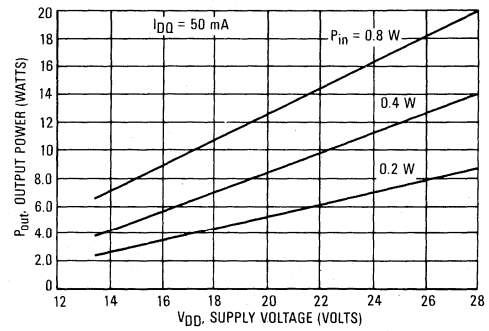
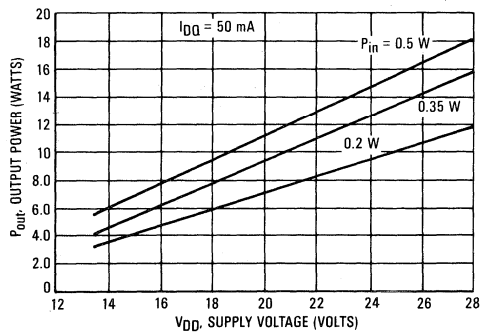
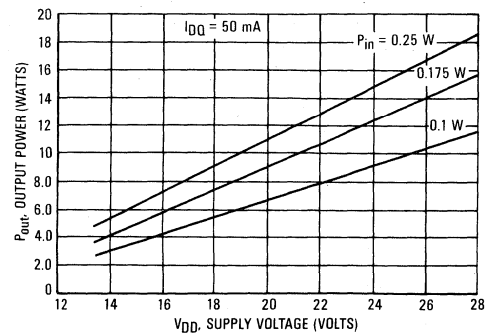
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 400 MHzFIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 300 MHzFIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 225 MHzFIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

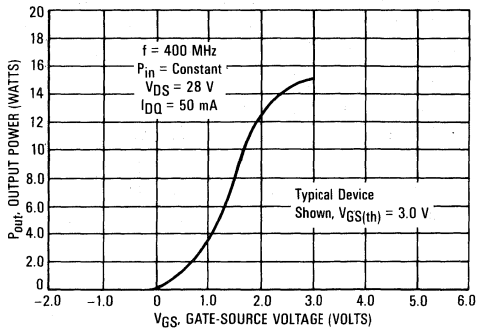


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

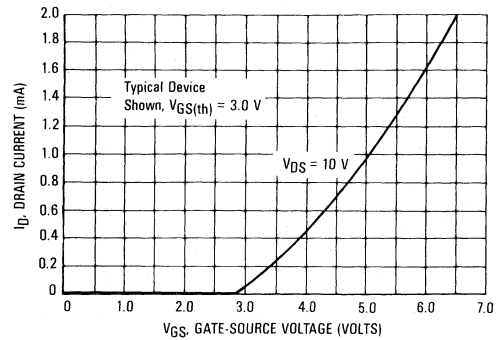


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

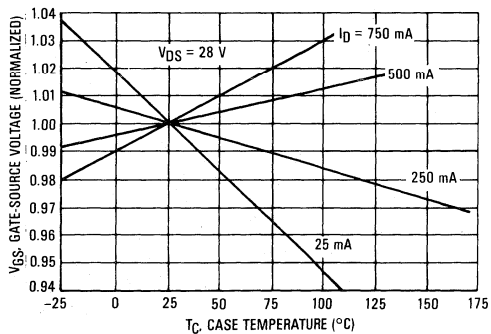


FIGURE 11 — CAPACITANCE versus DRAIN-SOURCE VOLTAGE

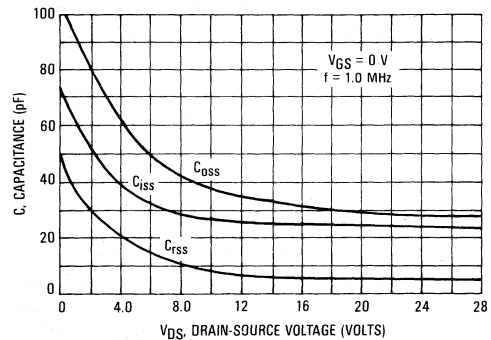


FIGURE 12 — DC SAFE OPERATING AREA

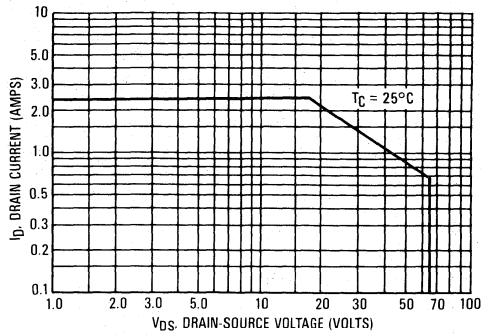


FIGURE 13 — LARGE SIGNAL SERIES EQUIVALENT INPUT IMPEDANCE, Z_{in}

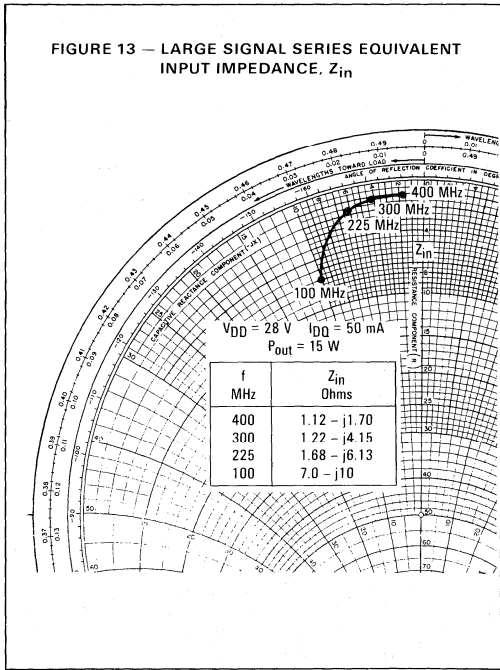


FIGURE 14 — LARGE SIGNAL SERIES EQUIVALENT OUTPUT IMPEDANCE, Z_{OL}^*

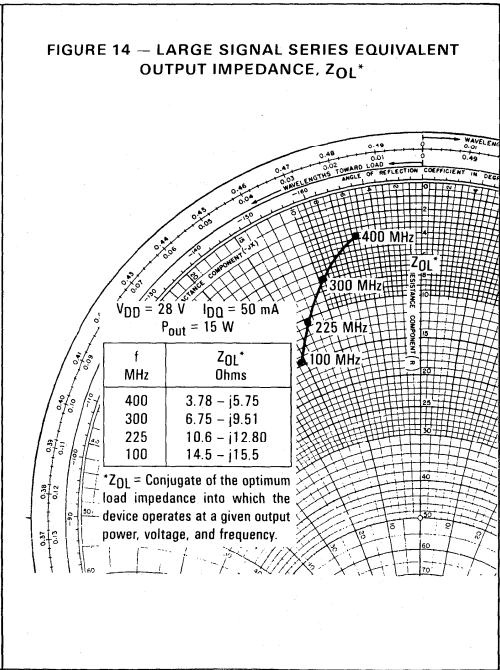


FIGURE 15 — COMMON SOURCE SCATTERING PARAMETERS
50 OHM SYSTEM
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
2.0	0.996	-11	34.29	171	0.007	+80	0.730	-12
5.0	0.983	-27	33.00	159	0.016	+73	0.729	-30
10	0.943	-51	31.76	147	0.030	+60	0.728	-57
20	0.871	-86	24.38	130	0.047	+41	0.726	-94
30	0.833	-109	18.82	118	0.054	+30	0.727	-116
40	0.811	-123	14.93	110	0.058	+23	0.728	-129
50	0.796	-133	12.42	105	0.060	+18	0.729	-138
60	0.788	-140	10.45	101	0.061	+14	0.729	-143
70	0.782	-145	9.13	97	0.061	+11	0.729	-148
80	0.779	-149	8.01	94	0.062	+8.9	0.731	-151
90	0.777	-152	7.12	92	0.062	+7.1	0.733	-153
100	0.776	-155	6.48	89	0.062	+5.3	0.735	-155
110	0.775	-157	5.92	87	0.062	+3.9	0.737	-156
120	0.775	-158	5.45	85	0.062	+2.4	0.739	-158
130	0.775	-160	5.03	83	0.062	+1.5	0.741	-159
140	0.775	-161	4.69	81	0.062	+0.4	0.743	-159
150	0.775	-162	4.37	80	0.061	-0.6	0.744	-160
160	0.777	-163	4.10	78	0.062	-1.3	0.746	-161
170	0.777	-163	3.87	77	0.061	-2.2	0.748	-161
180	0.778	-164	3.65	75	0.061	-2.8	0.750	-161
190	0.780	-165	3.46	74	0.061	-3.7	0.753	-162
200	0.781	-165	3.29	72	0.060	-4.2	0.755	-162
225	0.784	-166	2.87	69	0.060	-5.8	0.765	-163
250	0.788	-166	2.57	66	0.059	-7.7	0.770	-163
275	0.790	-167	2.30	64	0.059	-9.0	0.780	-163
300	0.792	-167	2.20	62	0.059	-11	0.795	-163
325	0.794	-168	1.94	57	0.059	-12	0.812	-163
350	0.794	-169	1.78	56	0.058	-15	0.815	-163
375	0.799	-169	1.67	54	0.057	-16	0.826	-163
400	0.805	-169	1.56	51	0.055	-17	0.836	-163
425	0.815	-169	1.45	50	0.054	-17	0.862	-163
450	0.825	-169	1.39	47	0.053	-17	0.860	-162
475	0.834	-170	1.32	45	0.052	-17	0.871	-162
500	0.837	-170	1.23	42	0.051	-16	0.871	-162
525	0.838	-171	1.16	41	0.050	-14	0.872	-162
550	0.843	-171	1.11	39	0.048	-13	0.883	-162
575	0.845	-172	1.07	37	0.048	-12	0.894	-162
600	0.855	-172	1.03	35	0.046	-10	0.901	-163
625	0.856	-173	0.977	33	0.045	-9.0	0.905	-163
650	0.875	-173	0.947	32	0.044	-7.0	0.921	-163
675	0.885	-173	0.914	30	0.044	-5.0	0.938	-163
700	0.888	-174	0.873	27	0.043	-4.0	0.949	-164
725	0.892	-174	0.841	27	0.042	-1.0	0.947	-164
750	0.900	-174	0.821	26	0.043	+2.0	0.970	-164
775	0.910	-175	0.814	24	0.044	+4.0	0.978	-164
800	0.918	-176	0.775	22	0.045	+8.0	0.978	-164

FIGURE 16 — S_{11} , INPUT REFLECTION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

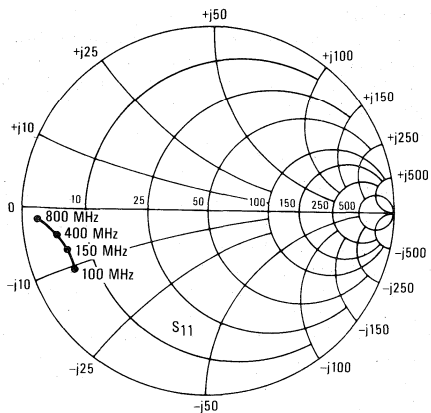


FIGURE 17 — S_{12} , REVERSE TRANSMISSION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

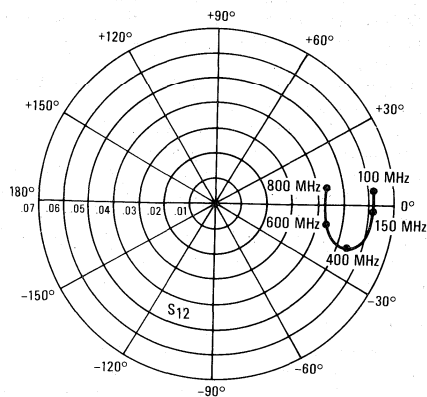


FIGURE 18 — S_{21} , FORWARD TRANSMISSION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

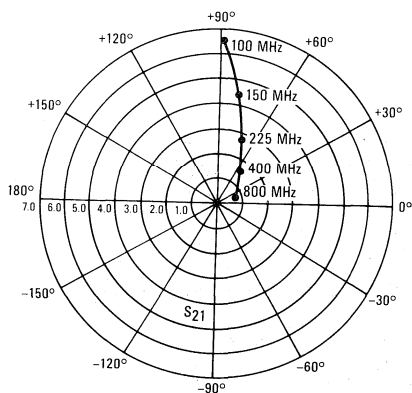
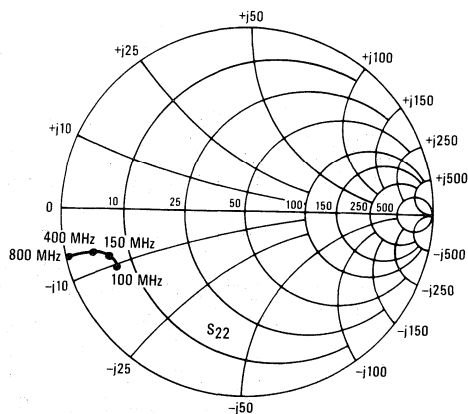


FIGURE 19 — S_{22} , OUTPUT REFLECTION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$



DESIGN CONSIDERATIONS

The MRF162 is a TMOS RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier applications. Motorola TMOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

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The major advantages of TMOS RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF162 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF162 was characterized at $I_{DQ} = 50$ mA, which is the suggested minimum value of I_{DQ} . For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a

simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

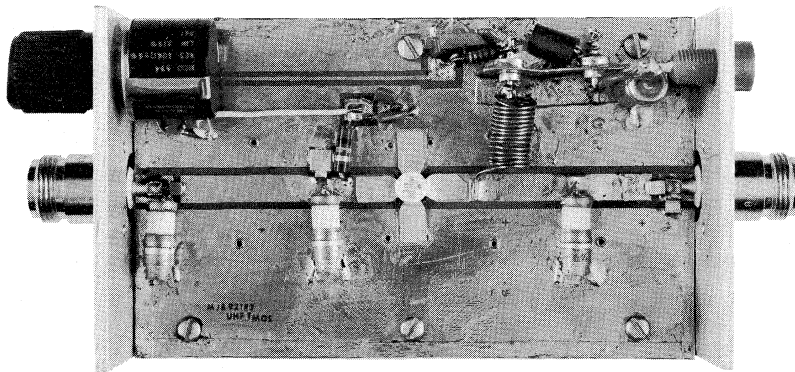
Power output of the MRF162 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC, and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for the MRF162. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of TMOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of TMOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF162, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF162 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two port network theory and stability.

FIGURE 20 — 400 MHz TEST CIRCUIT



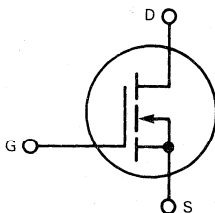
MRF163

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
TMOS RF POWER FIELD-EFFECT TRANSISTOR**

... designed for wideband large-signal output and driver applications in the 2.0 to 400 MHz range.

- Guaranteed 28 Volt, 400 MHz Performance
Output Power = 25 Watts
Minimum Gain = 10 dB
Efficiency = 50% (Typical)
- Small-Signal and Large-Signal Characterization
- 100% Tested for Load Mismatch At All Phase Angles
With 30:1 VSWR
- Low Noise Figure — 2.5 dB (Typ) at 500 mA, 400 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage ($R_{GS} = 1.0 \text{ M}\Omega$)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	5.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	87.5 0.500	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

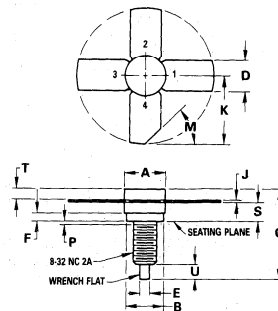
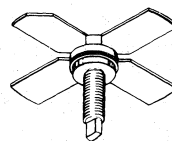
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	$^\circ\text{C}/\text{W}$
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.			

25 W 2.0-400 MHz

**N-CHANNEL TMOS
BROADBAND RF POWER**

FET



STYLE 3:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 10$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	4.0	mAdc
Gate-Source Leakage Current ($V_{GS} = 40$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μAdc

ON CHARACTERISTICS

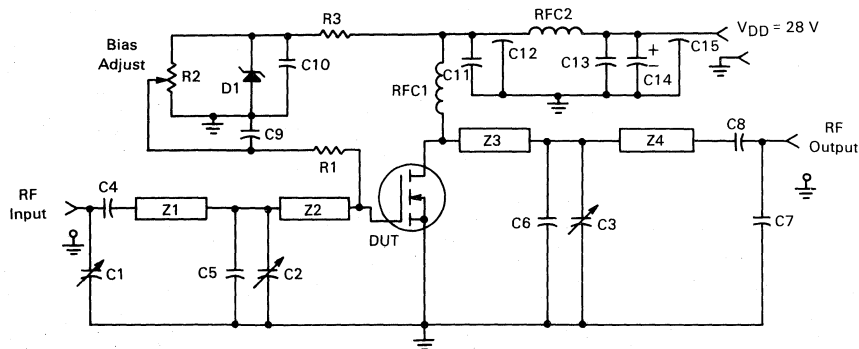
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 25$ mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 500$ mA)	g_{fs}	500	750	—	mmhos

DYNAMIC CHARACTERISTICS

Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	48	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	54	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	11	—	pF

FUNCTIONAL CHARACTERISTICS (Figure 1)

Noise Figure ($V_{DS} = 28$ Vdc, $I_D = 500$ mA, $f = 400$ MHz, $Z_S = 3.23 + j2.57 \Omega$, $Z_L = 2.11 + j2.97 \Omega$)	NF	—	2.5	—	dB
Common Source Power Gain ($V_{DD} = 28$ Vdc, $P_{out} = 25$ W, $f = 400$ MHz, $I_{DQ} = 25$ mA)	G_{ps}	10	12	—	dB
Drain Efficiency ($V_{DD} = 28$ Vdc, $P_{out} = 25$ W, $f = 400$ MHz, $I_{DQ} = 25$ mA)	η	45	50	—	%
Electrical Ruggedness ($V_{DD} = 28$ Vdc, $P_{out} = 25$ W, $f = 400$ MHz, $I_{DQ} = 25$ mA, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT

C1, C2, C3 — 1–20 pF Johanson or Equivalent
 C4, C8 — 270 pF, 100 Mil Chip Cap
 C5, C6 — 18 pF Mini-Unleco or Equivalent
 C7 — 12 pF Mini-Unleco or Equivalent
 C9 — 0.01 μF , 50 V Disc Ceramic
 C10, C11, C13 — 0.1 μF , 50 V Disc Ceramic
 C12, C15 — 680 pF Feedthru
 C14 — 20 μF , 50 V
 D1 — 1N5925A Motorola Zener
 R1 — 10 k Ω , 1/4 W

R2 — 10 Turns 10 k Ω
 R3 — 1.6 k Ω , 1/4 W
 RFC1 — 10 Turns, 0.300" ID #20 AWG
 Enamel Closewound
 RFC2 — Ferroxcube VK-200 — 19/4B
 Z1 — 1.350" \times 0.250" Microstrip
 Z2 — 0.600" \times 0.250" Microstrip
 Z3 — 0.710" \times 0.250" Microstrip
 Z4 — 1.300" \times 0.250" Microstrip
 Board — Glass Teflon, 62 Mils, $\epsilon_r = 2.56$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

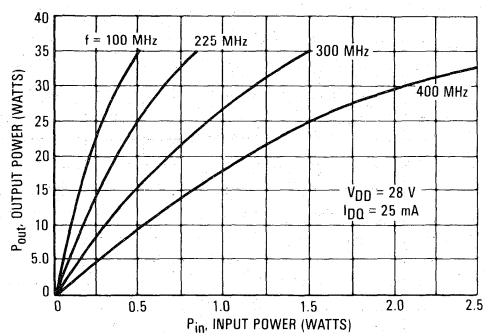


FIGURE 3 — OUTPUT POWER versus INPUT POWER

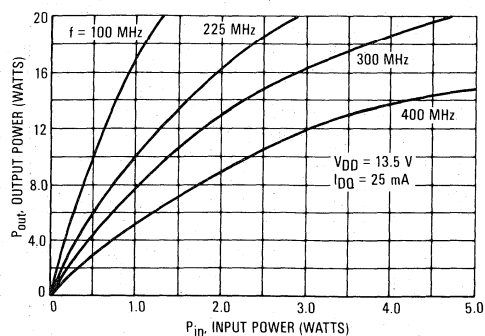
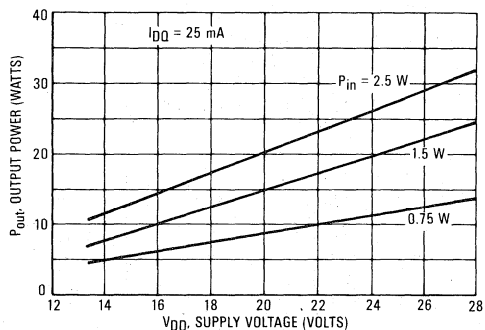
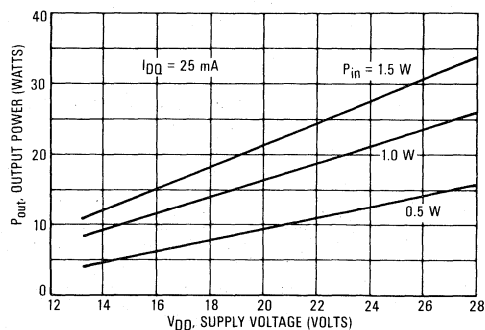
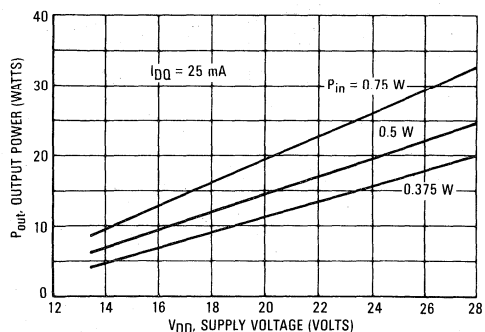
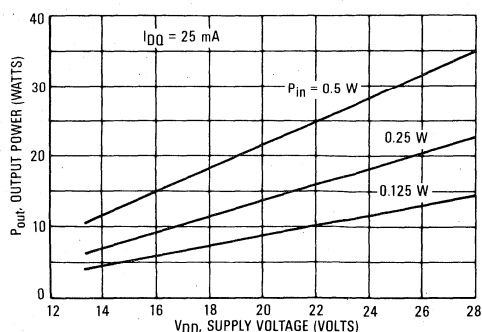
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 400\text{ MHz}$ FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 300\text{ MHz}$ FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 225\text{ MHz}$ FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 100\text{ MHz}$ 

FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

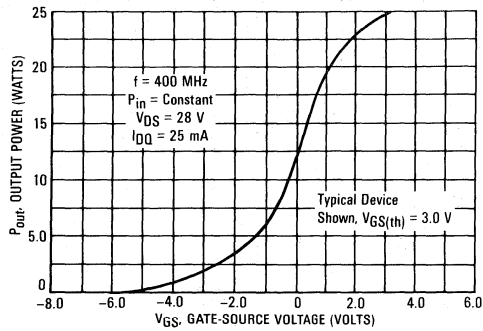


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

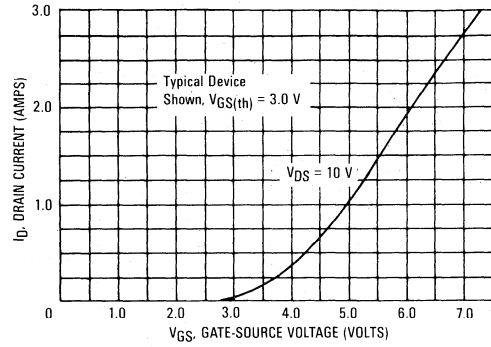


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

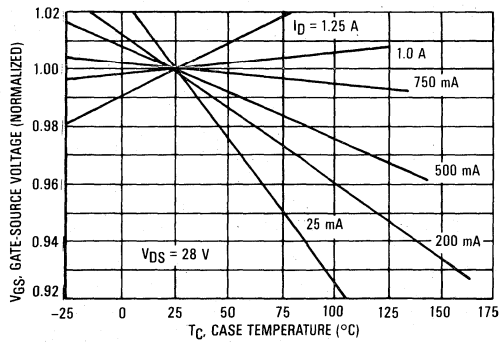


FIGURE 11 — CAPACITANCE versus DRAIN-SOURCE VOLTAGE

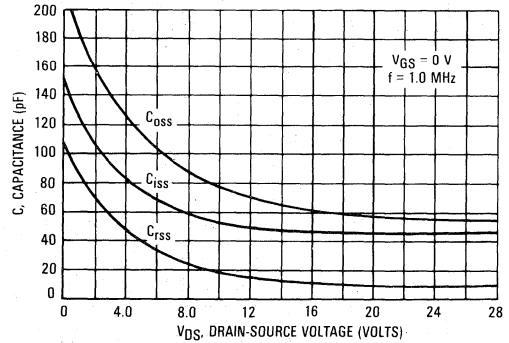


FIGURE 12 — DC SAFE OPERATING AREA

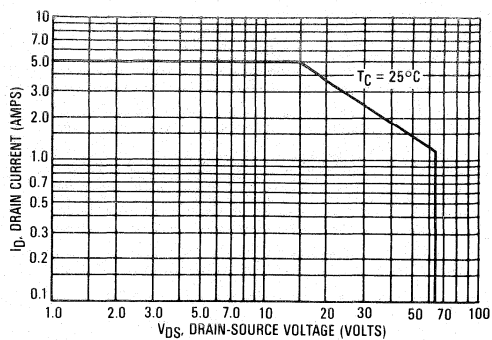


FIGURE 13 — INPUT AND OUTPUT IMPEDANCE

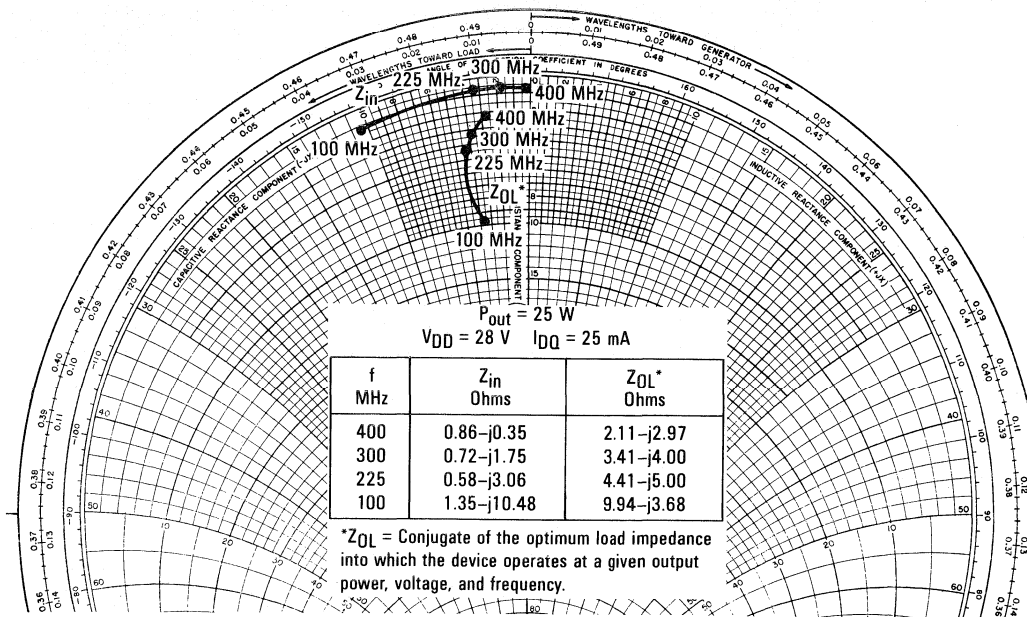


FIGURE 14 — COMMON SOURCE SCATTERING PARAMETERS
50 OHM SYSTEM
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
2.0	0.985	-30	56.97	166	0.010	+63.9	0.611	-36
10	0.875	-105	34.12	125	0.032	+30.6	0.736	-116
25	0.841	-145	16.17	104	0.038	+9.2	0.798	-152
50	0.833	-162	8.201	92.7	0.038	+1.6	0.800	-165
75	0.836	-167	5.496	86.8	0.037	-2.5	0.802	-168
100	0.838	-170	4.121	82.3	0.039	-3.0	0.804	-170
125	0.838	-171	3.255	78.6	0.039	-5.8	0.809	-170
150	0.840	-172	2.718	74.3	0.037	-8.5	0.815	-171
175	0.844	-173	2.326	70.8	0.037	-9.6	0.819	-171
200	0.849	-173	2.027	67.2	0.036	-10.4	0.824	-171
225	0.851	-173	1.782	64.0	0.036	-10.3	0.833	-171
250	0.857	-173	1.593	60.9	0.034	-11.7	0.839	-171
275	0.862	-173	1.438	58.9	0.035	-11.1	0.844	-171
300	0.866	-173	1.319	55.6	0.033	-12.1	0.846	-170
325	0.872	-173	1.209	52.3	0.032	-12.7	0.861	-170
350	0.875	-173	1.110	49.0	0.031	-13.4	0.873	-170
375	0.879	-173	1.030	46.7	0.031	-12.2	0.876	-170
400	0.882	-173	0.966	44.1	0.030	-14.6	0.883	-170
425	0.888	-173	0.904	41.3	0.029	-13.4	0.888	-170
450	0.891	-173	0.836	39.4	0.028	-11.7	0.895	-170
475	0.893	-173	0.792	37.1	0.027	-8.8	0.902	-170
500	0.901	-173	0.748	35.2	0.027	-6.1	0.911	-170
525	0.906	-173	0.715	32.4	0.025	-6.0	0.921	-170
550	0.911	-173	0.679	30.2	0.024	-6.0	0.928	-170
575	0.912	-173	0.637	28.7	0.024	-3.9	0.934	-170
600	0.913	-173	0.605	26.9	0.024	-1.0	0.939	-170
625	0.919	-174	0.579	25.3	0.024	+1.0	0.947	-170
650	0.921	-174	0.566	23.0	0.025	+10.1	0.961	-170
675	0.927	-174	0.540	22.6	0.025	+12.1	0.963	-170
700	0.927	-174	0.510	19.9	0.025	+16.5	0.966	-170
725	0.927	-173	0.485	19.5	0.025	+23.1	0.967	-170
750	0.933	-174	0.481	17.4	0.026	+25.3	0.967	-170
775	0.937	-174	0.453	17.2	0.028	+28.0	0.976	-170
800	0.942	-174	0.448	16.8	0.030	+33.8	0.976	-170

FIGURE 15 — S_{11} , INPUT REFLECTION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

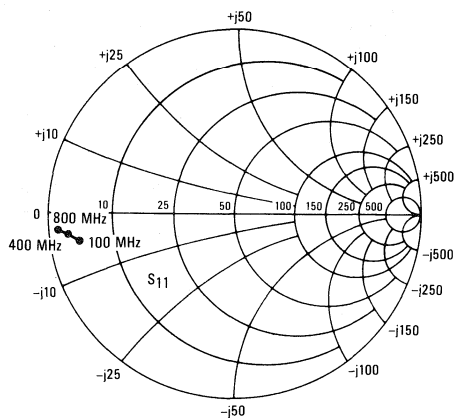


FIGURE 16 — S_{12} , REVERSE TRANSMISSION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

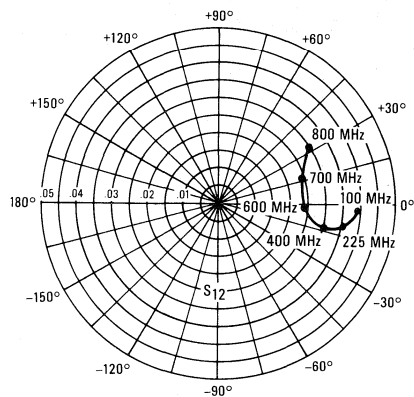


FIGURE 17 — S_{21} , FORWARD TRANSMISSION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

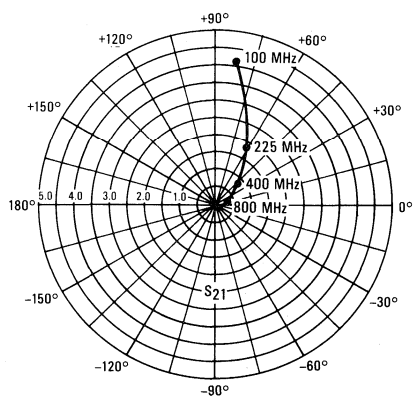
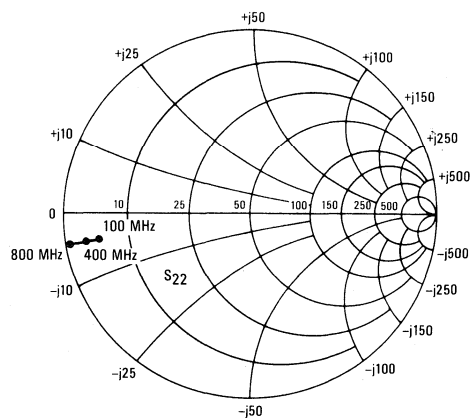


FIGURE 18 — S_{22} , OUTPUT REFLECTION COEFFICIENT
versus FREQUENCY
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$



DESIGN CONSIDERATIONS

The MRF163 is a TMOS RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier applications. Motorola TMOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

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DC BIAS

The MRF163 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF163 was characterized at $I_{DQ} = 25$ mA, which is the suggested minimum value of I_{DQ} . For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a

simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

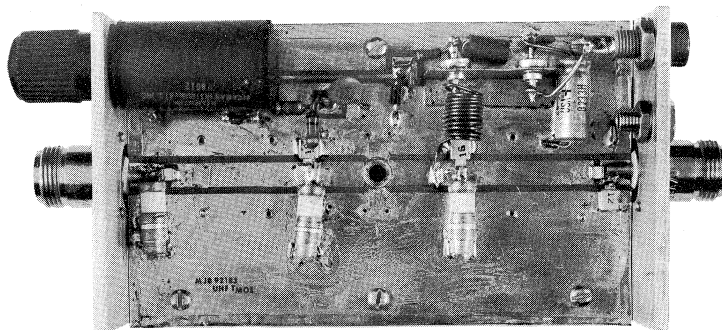
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AMPLIFIER DESIGN

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RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF163, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF163 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two port network theory and stability.

FIGURE 19 — 400 MHz TEST CIRCUIT



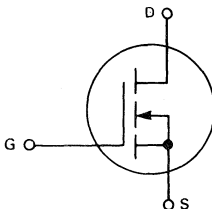
MRF171

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
 TMOS RF POWER FIELD-EFFECT TRANSISTOR**

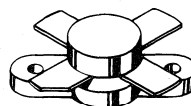
... designed primarily for wideband large-signal output and driver stages in the 2.0-200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
- Output Power = 45 Watts
 Minimum Gain = 12 dB
 Efficiency = 50% (Min)
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Excellent Thermal Stability, Ideally Suited for Class A Operation
- Low Noise Figure — 1.5 dB Typ at 1.0 A, 150 MHz



45 W 2.0-200 MHz

**N-CHANNEL TMOS
 BROADBAND RF POWER
 FET**



MAXIMUM RATINGS

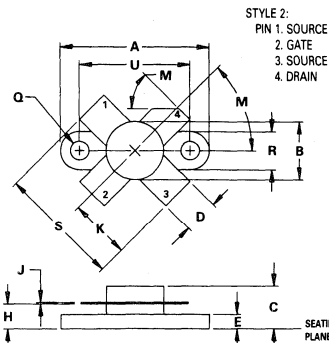
Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGR}^*	65	Vdc
Gate-Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	4.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	115 0.66	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	$^\circ\text{C/W}$

* $R_{GS} = 1.0 \text{ M}\Omega$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.



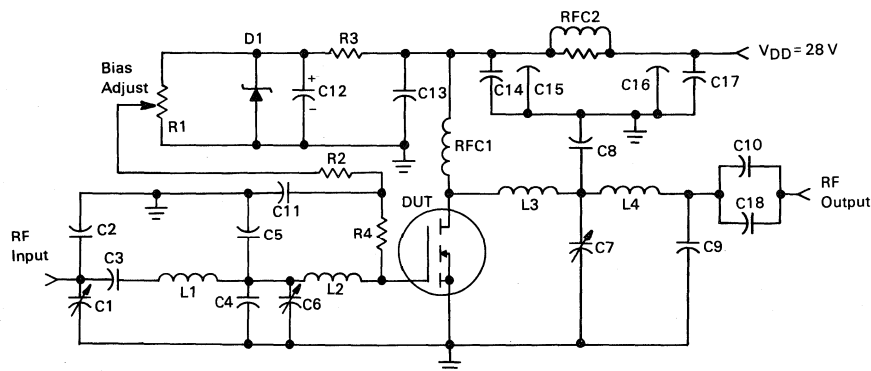
- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 10$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	5.0	mA _{dc}
Gate-Source Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μA_{dc}
ON CHARACTERISTICS					
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 25$ mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 1.0$ A)	g_{fs}	0.7	1.1	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	55	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	70	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	14	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS} = 28$ Vdc, $I_D = 1.0$ A, $f = 150$ MHz)	NF	—	1.5	—	dB
Common Source Power Gain (Figure 1) ($V_{DD} = 28$ Vdc, $P_{out} = 45$ W, $f = 150$ MHz, $I_{DQ} = 25$ mA)	G_{ps}	12	15	—	dB
Drain Efficiency (Figure 1) ($V_{DD} = 28$ Vdc, $P_{out} = 45$ W, $f = 150$ MHz, $I_{DQ} = 25$ mA)	η	50	60	—	%
Electrical Ruggedness (Figure 1) ($V_{DD} = 28$ Vdc, $P_{out} = 45$ W, $f = 150$ MHz, $I_{DQ} = 25$ mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 150 MHz TEST CIRCUIT

C1, C6, C7 — 1.0–20 pF Johanson
 C2, C4, C5, C8 — 63 pF ATC Chip (100 mils)
 C3, C10, C18 — 680 pF ATC Chip (100 mils)
 C9 — 12 pF ATC Chip (100 mils)
 C11, C13, C14, C17 — 0.1 μF Erie Redcap, 50 V
 C12 — 25 μF , 50 V
 C15, C16 — 680 pF Feedthru
 D1 — 1N5925A Motorola Zener
 L1 — 2 Turns, #18 AWG, 0.3" ID, 0.3" Long
 L2 — 1-1/4 Turns, #18 AWG, 0.21" ID

L3 — 1-1/4 Turns, #18 AWG, 0.21" ID
 L4 — 2 Turns, #18 AWG, 0.23" ID, 0.15" Long
 RFC1 — 20 Turns, #20 AWG Enameled, 0.3" ID,
 Close Wound
 RFC2 — 15 Turns, #20 AWG Enameled on 2.0 W,
 10 Ω Resistor
 R1 — 10 k Ω , 10 Turns Helipot 7216-R10K-L.25
 R2 — 10 k Ω , 1/4 W
 R3 — 1.8 k Ω , 1/2 W
 R4 — 47 Ω , 1/2 W

FIGURE 2 — OUTPUT POWER versus INPUT POWER

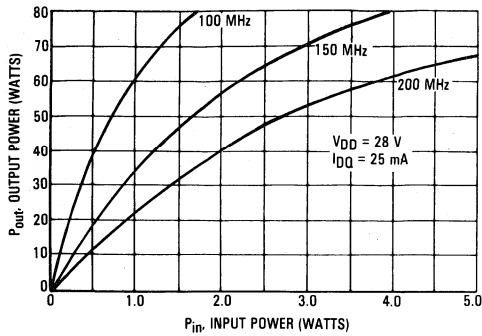


FIGURE 3 — OUTPUT POWER versus INPUT POWER

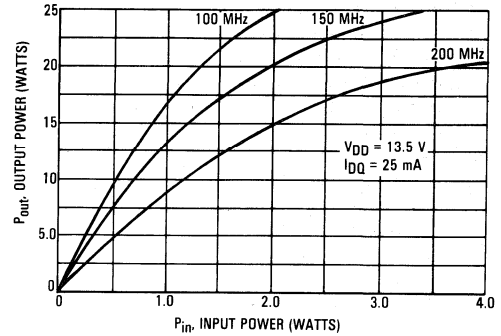
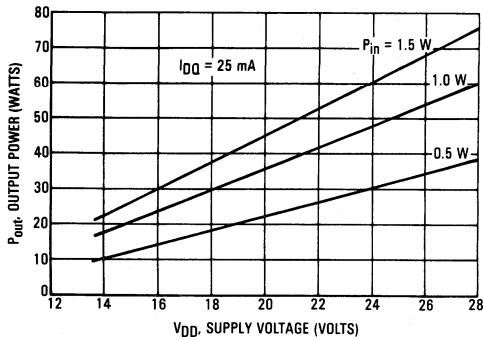
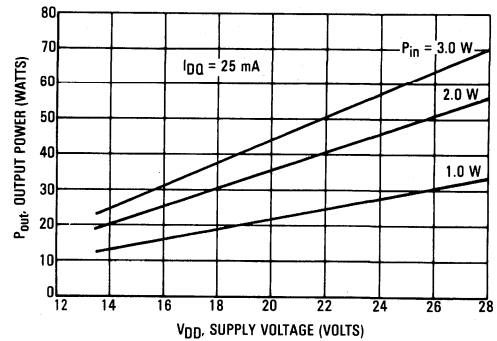
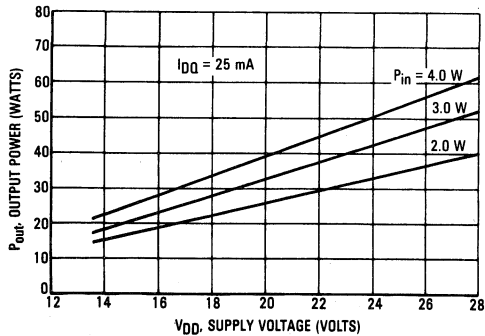
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 100\text{ MHz}$ FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 150\text{ MHz}$ FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 200\text{ MHz}$ 

FIGURE 7 — POWER GAIN versus FREQUENCY

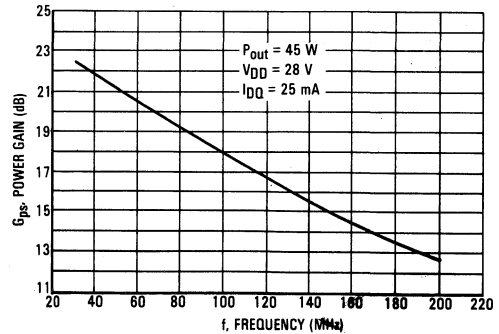


FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

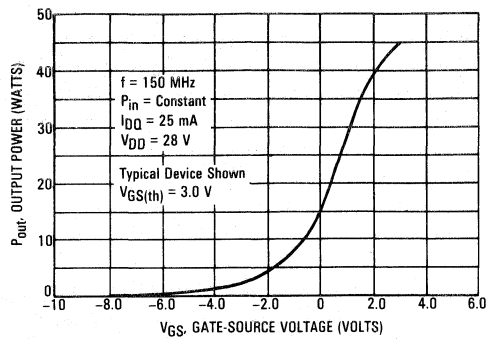


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

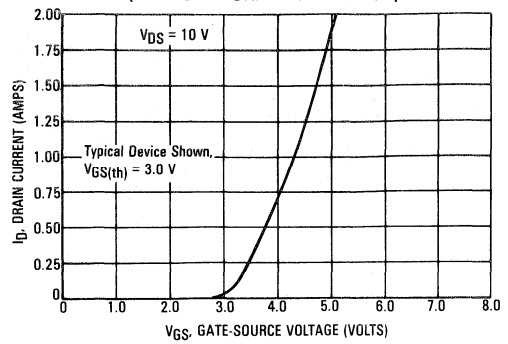


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

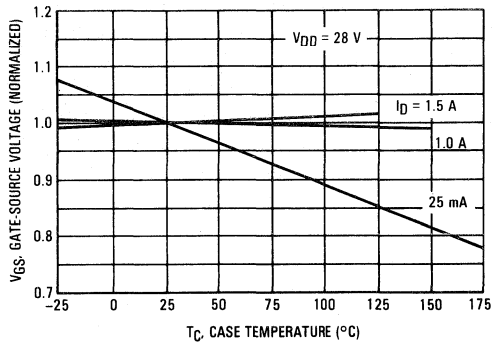


FIGURE 11 — CAPACITANCE versus DRAIN VOLTAGE

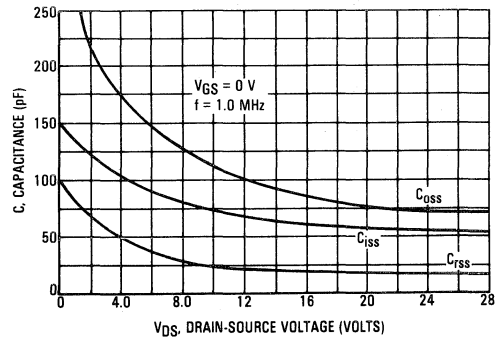


FIGURE 12 — DC SAFE OPERATING AREA

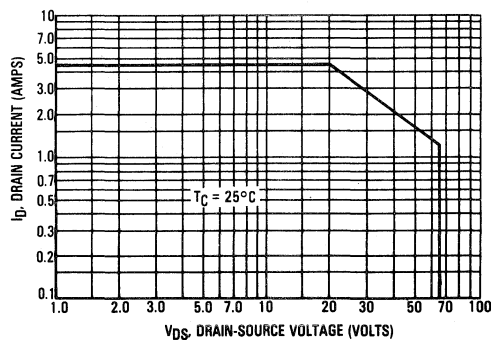
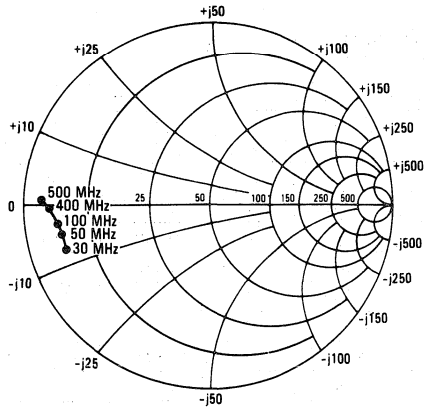


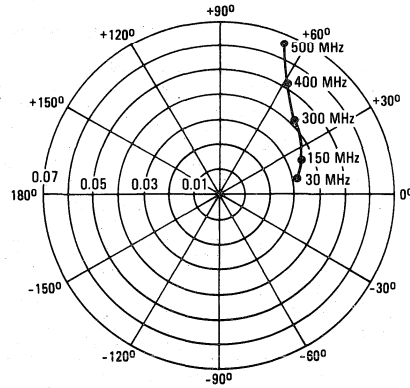
FIGURE 13 — COMMON SOURCE SCATTERING PARAMETERS
 $V_{DS} = 28 \text{ V}$, $I_D = 0.5 \text{ A}$

f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
2.0	0.966	-50	72.4	153	0.014	63	0.674	-59
5.0	0.891	-97	50.8	128	0.025	39	0.757	-109
10	0.841	-132	30.1	110	0.030	23	0.801	-141
20	0.821	-155	15.9	99	0.032	14	0.818	-160
30	0.817	-162	10.7	93	0.032	11	0.822	-166
40	0.816	-167	8.06	90	0.032	10	0.823	-169
50	0.816	-169	6.45	88	0.032	11	0.825	-171
60	0.816	-171	5.37	85	0.032	11	0.826	-172
70	0.816	-172	4.60	84	0.032	12	0.828	-173
80	0.816	-172	4.01	82	0.032	13	0.829	-174
90	0.816	-173	3.56	80	0.033	14	0.830	-174
100	0.816	-173	3.15	77	0.034	15	0.832	-174
110	0.816	-173	2.85	76	0.035	16	0.832	-175
120	0.816	-173	2.59	75	0.036	18	0.832	-175
130	0.817	-174	2.40	74	0.036	19	0.832	-175
140	0.817	-174	2.23	72	0.037	20	0.834	-175
150	0.820	-174	2.09	71	0.037	21	0.835	-175
160	0.823	-174	1.97	70	0.037	22	0.836	-175
170	0.825	-175	1.85	69	0.037	23	0.839	-175
180	0.826	-175	1.75	68	0.037	25	0.840	-175
190	0.829	-175	1.66	67	0.037	26	0.843	-175
200	0.832	-175	1.59	66	0.038	27	0.845	-175
250	0.844	-176	1.24	61	0.039	37	0.856	-175
300	0.855	-176	1.02	55	0.042	45	0.867	-174
350	0.862	-177	0.88	51	0.047	53	0.878	-174
400	0.868	-178	0.76	48	0.052	59	0.885	-174
450	0.873	-179	0.67	45	0.059	64	0.897	-174
500	0.907	+179	0.63	42	0.067	67	0.892	-175

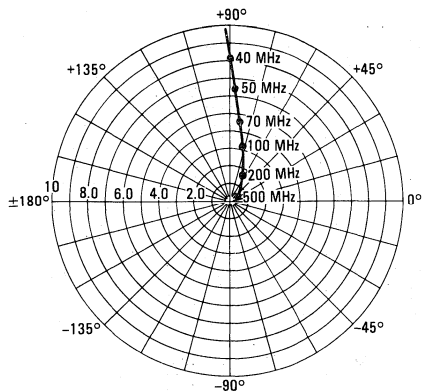
**FIGURE 14 — S_{11} , INPUT REFLECTION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 0.5 \text{ A}$



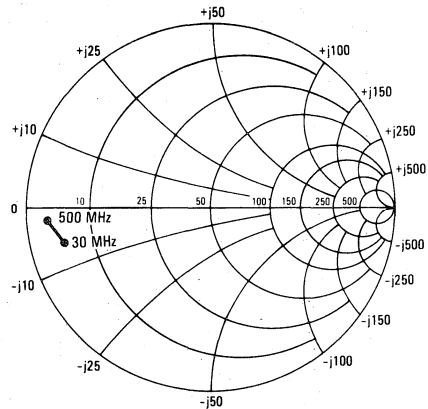
**FIGURE 15 — S_{12} , REVERSE TRANSMISSION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 0.5 \text{ A}$



**FIGURE 16 — S_{21} , FORWARD TRANSMISSION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 0.5 \text{ A}$



**FIGURE 17 — S_{22} , OUTPUT REFLECTION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 0.5 \text{ A}$



DESIGN CONSIDERATIONS

The MRF171 is a TMOS RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for VHF power amplifier and oscillator applications. Motorola TMOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with "V-groove" vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of TMOS RF power FETs include high-gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF171 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF171 was characterized at $I_{DQ} = 25$ mA, which is the suggested minimum value of I_{DQ} . For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF171 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC, and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF171. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of TMOS FETs helps ease the task of broadband network design. Both small-signal scattering parameters and large-signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of TMOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF171, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. The MRF171 was characterized with a 47-ohm input shunt loading resistor. Two port parameter stability analysis with the MRF 171 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two-port network theory and stability.

Input resistive loading is not feasible in low noise applications. The MRF171 noise figure data was generated in a circuit with drain loading and a low loss input network.

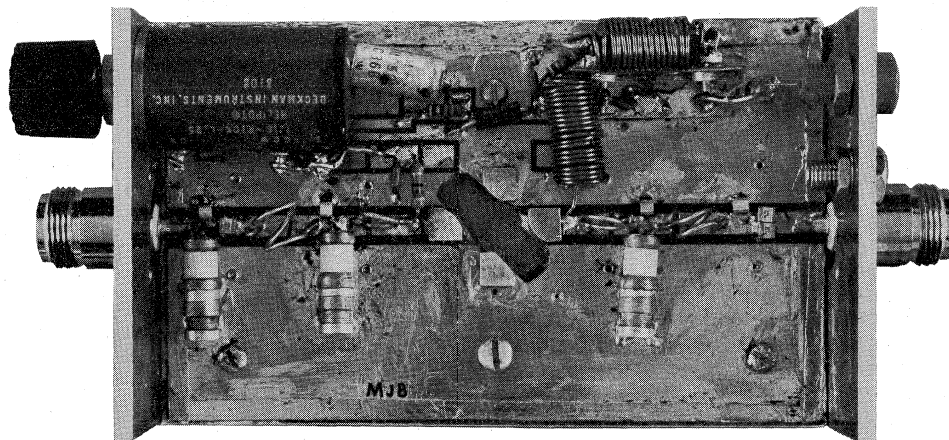
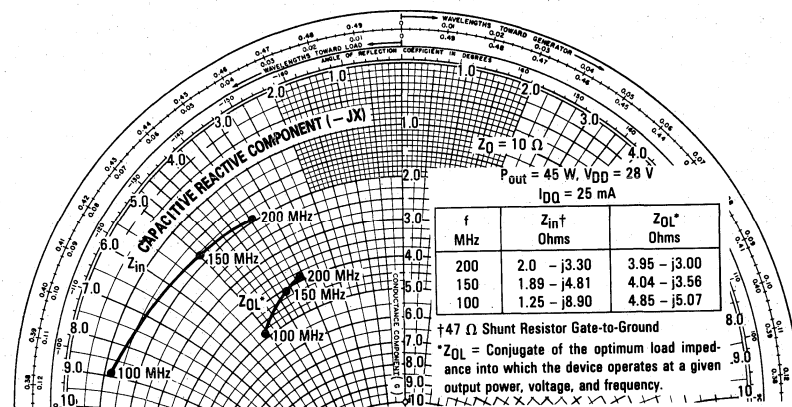


FIGURE 18 — 150 MHz TEST CIRCUIT

FIGURE 19 — LARGE-SIGNAL SERIES EQUIVALENT
INPUT/OUTPUT IMPEDANCE



MRF172

The RF TMOS Line

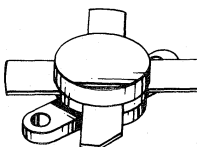
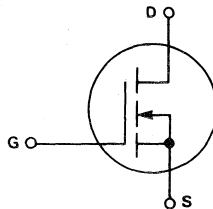
N-CHANNEL ENHANCEMENT-MODE TMOS RF POWER FIELD-EFFECT TRANSISTOR

... designed primarily for wideband large-signal output and driver stages in the 2.0-200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc

Output Power = 80 Watts
Minimum Gain = 10 dB
Efficiency = 50% (Min)

- Excellent Thermal Stability, Ideally Suited for Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure— 1.5 dB Typ at 2.0 A, 150 MHz



80 W 2.0-200 MHz N-CHANNEL TMOS BROADBAND RF POWER FET

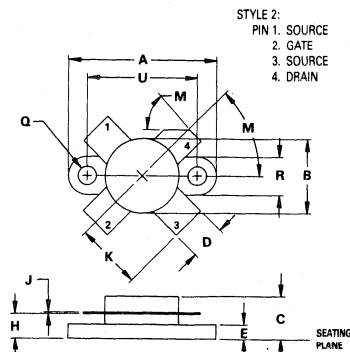
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	65	Vdc
Drain — Gate Voltage ($R_{GS} = 1.0 \text{ M}\Omega$)	V_{DGR}	65	Vdc
Gate — Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	9.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	220 1.26	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to $+150$	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.80	$^\circ\text{C}/\text{W}$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45°	NOM	45°	NOM
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 50$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	5.0	mAdc
Gate-Source Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μAdc

ON CHARACTERISTICS

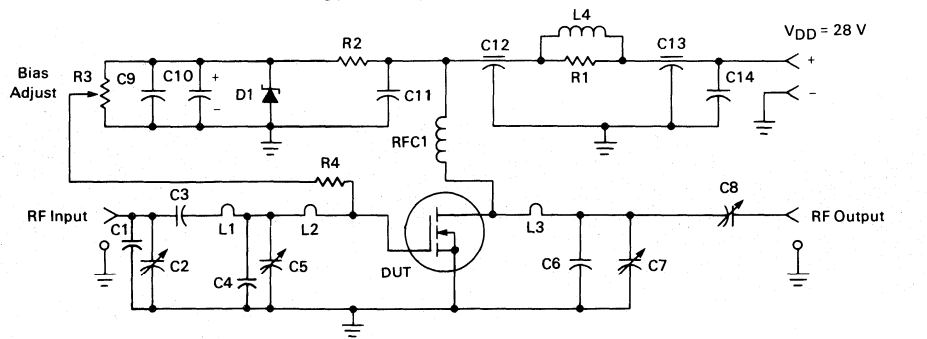
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 50$ mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 2.0$ A)	g_{fs}	1.2	1.8	—	mhos

DYNAMIC CHARACTERISTICS

Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	100	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	135	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	26	—	pF

FUNCTIONAL CHARACTERISTICS (Figure 1)

Noise Figure ($V_{DD} = 28$ Vdc, $I_D = 2.0$ A, $f = 150$ MHz)	NF	—	1.5	—	dB
Common Source Power Gain ($V_{DD} = 28$ Vdc, $P_{out} = 80$ W, $f = 150$ MHz, $I_{DQ} = 50$ mA)	G_{ps}	10	12.3	—	dB
Drain Efficiency ($V_{DD} = 28$ Vdc, $P_{out} = 80$ W, $f = 150$ MHz, $I_{DQ} = 50$ mA)	η	50	60	—	%
Electrical Ruggedness ($V_{DD} = 28$ Vdc, $P_{out} = 80$ W, $f = 150$ MHz, $I_{DQ} = 50$ mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 150 MHz TEST CIRCUIT

C1 — 25 pF Unleco
 C2, C5, C7 — Arco 462, 5–80 pF
 C3 — 100 pF Unleco
 C4 — 40 pF Unleco
 C6 — 60 pF Unleco
 C8 — Arco 463, 9–180 pF
 C9, C11, C14 — 0.1 μF Erie Redcap
 C10 — 50 μF , 50 V
 C12, C13 — 680 pF Feedthru
 D1 — 1N5925A Motorola Zener

L1 — #16 AWG, 1-1/4 Turns, 0.213" ID
 L2 — #16 AWG, Hairpin
 L3 — #14 AWG, Hairpin
 L4 — 10 Turns #16 AWG Enameled Wire on R1
 RFC1 — 18 Turns #16 AWG Enameled Wire, 0.3" ID
 R1 — 10 Ω , 2.0 W
 R2 — 1.8 k Ω , 1/2 W
 R3 — 10 k Ω , 10 Turn Bourns
 R4 — 10 k Ω , 1/4 W

FIGURE 2 — OUTPUT POWER versus INPUT POWER

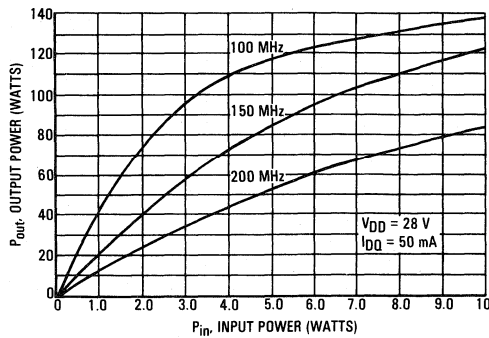


FIGURE 3 — OUTPUT POWER versus INPUT POWER

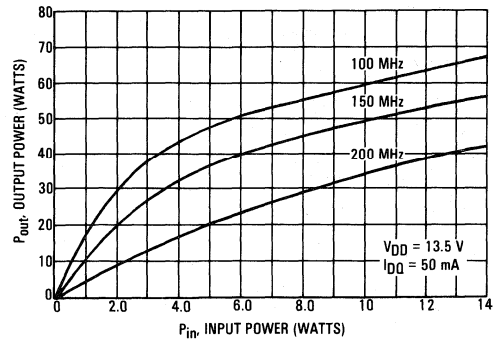
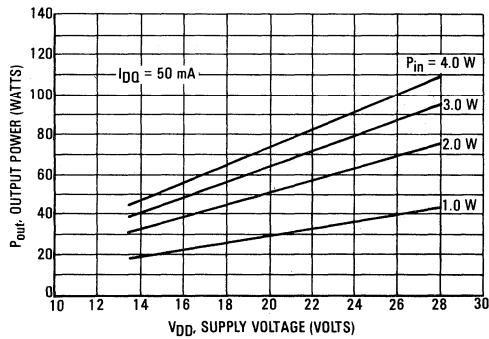
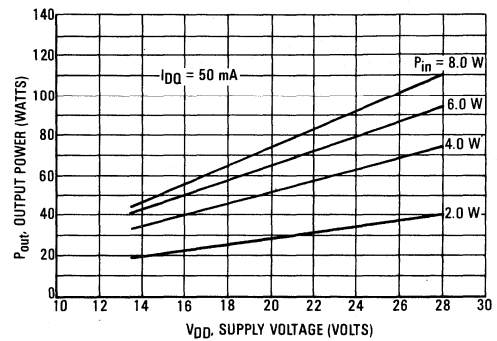
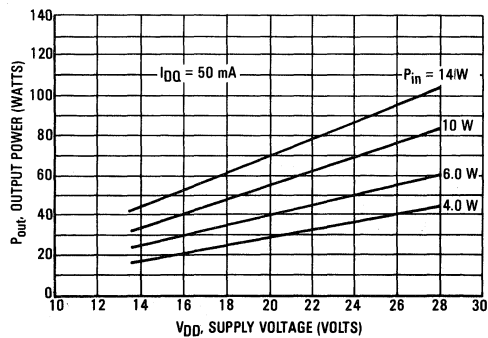
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 $f = 100\text{ MHz}$ FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 150\text{ MHz}$ FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 200\text{ MHz}$ 

FIGURE 7 — POWER GAIN versus FREQUENCY

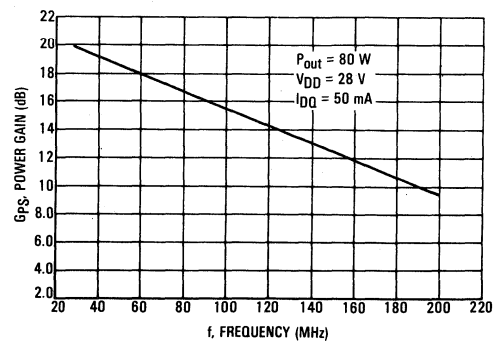


FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

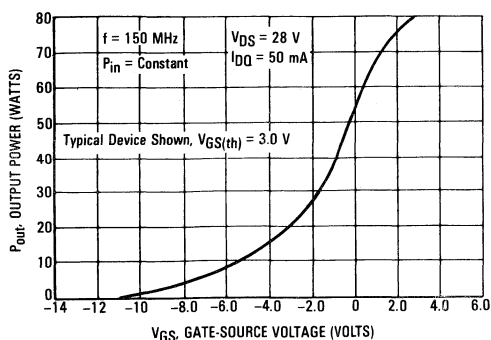


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

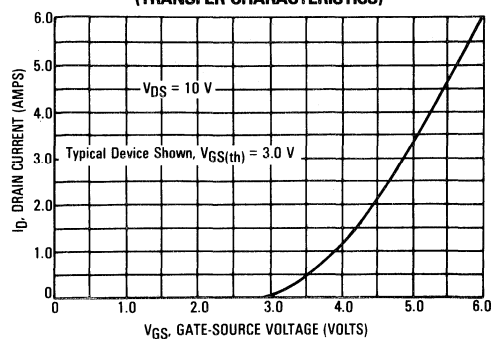


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

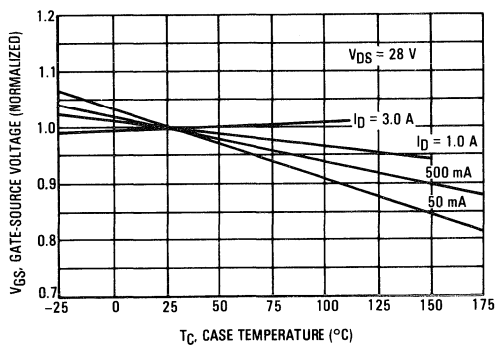


FIGURE 11 — CAPACITANCE versus DRAIN VOLTAGE

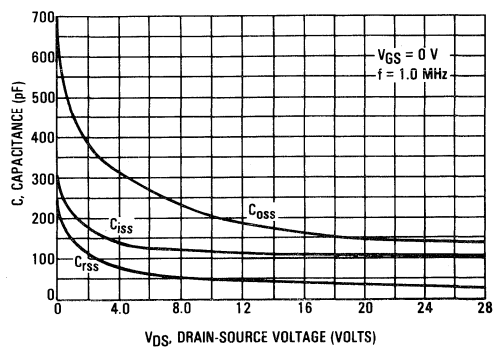


FIGURE 12 — DC SAFE OPERATING AREA

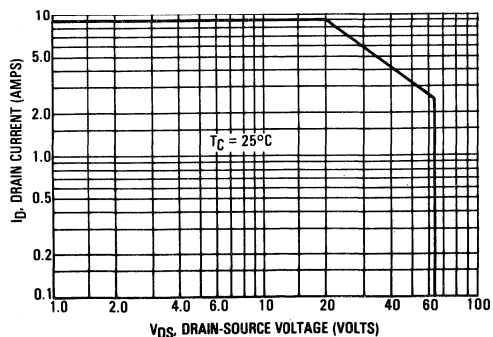
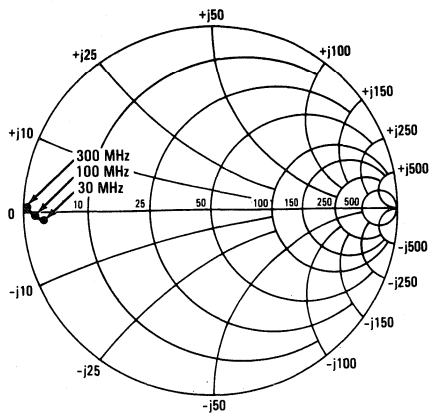


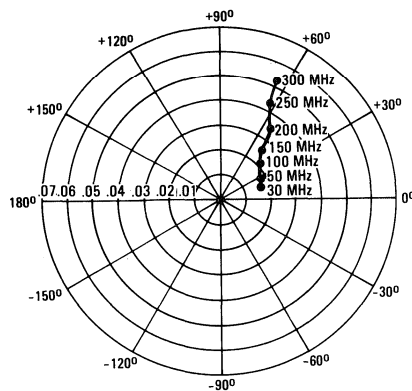
FIGURE 13 — COMMON SOURCE SCATTERING PARAMETERS
 $V_{DS} = 28 \text{ V}$, $I_D = 2.0 \text{ A}$

f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
2.0	0.928	-112	87.5	122	0.013	34	0.776	-128
5.0	0.902	-149	40.5	104	0.015	17	0.857	-158
10	0.897	-164	20.7	96	0.016	12	0.872	-169
20	0.896	-172	10.4	90	0.016	13	0.876	-174
30	0.896	-175	6.94	88	0.016	17	0.877	-176
40	0.896	-176	5.20	85	0.017	21	0.878	-177
50	0.897	-177	4.15	83	0.017	25	0.879	-177
60	0.897	-177	3.45	82	0.017	29	0.880	-177
70	0.898	-178	2.95	80	0.018	33	0.881	-177
80	0.899	-178	2.57	78	0.019	37	0.882	-177
90	0.901	-178	2.27	76	0.020	40	0.883	-177
100	0.903	-178	2.00	74	0.021	42	0.885	-177
110	0.905	-178	1.80	73	0.022	44	0.887	-177
120	0.907	-178	1.62	71	0.024	45	0.888	-177
130	0.908	-178	1.51	70	0.026	47	0.895	-177
140	0.909	-178	1.39	70	0.027	49	0.895	-177
150	0.910	-178	1.30	69	0.028	51	0.895	-177
160	0.911	-178	1.22	68	0.029	51	0.897	-177
170	0.912	-179	1.14	66	0.030	52	0.899	-177
180	0.921	-179	1.08	65	0.032	54	0.900	-177
190	0.921	-179	1.01	64	0.033	55	0.903	-177
200	0.922	-179	0.974	63	0.035	56	0.905	-177
210	0.920	-179	0.928	61	0.036	58	0.907	-176
220	0.915	-179	0.872	60	0.038	59	0.907	-176
230	0.915	-179	0.828	60	0.040	60	0.914	-176
240	0.917	-179	0.793	59	0.042	61	0.917	-176
250	0.922	-179	0.772	59	0.044	62	0.918	-176
260	0.927	+179	0.744	57	0.046	62	0.920	-176
270	0.928	+179	0.714	57	0.048	63	0.920	-176
280	0.929	+179	0.689	56	0.049	64	0.923	-176
290	0.929	+179	0.662	55	0.051	65	0.923	-176
300	0.938	+179	0.642	55	0.053	65	0.923	-176

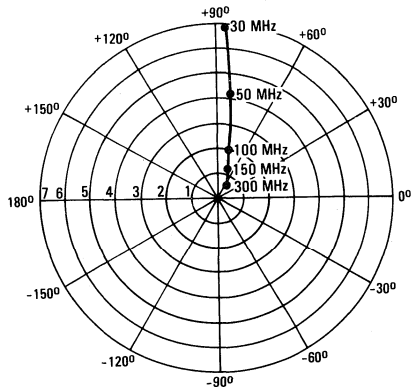
**FIGURE 14 — S_{11} , INPUT REFLECTION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 2.0 \text{ A}$



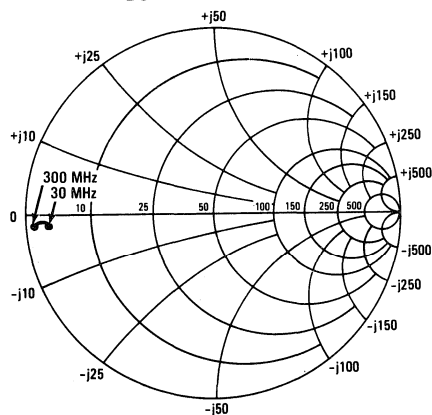
**FIGURE 15 — S_{12} , REVERSE TRANSMISSION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 2.0 \text{ A}$



**FIGURE 16 — S_{21} , FORWARD TRANSMISSION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 2.0 \text{ A}$



**FIGURE 17 — S_{22} , OUTPUT REFLECTION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 2.0 \text{ A}$



DESIGN CONSIDERATIONS

The MRF172 is a TMOS RF power N-channel enhancement mode field-effect transistor (FET) designed for VHF power amplifier applications. Motorola TMOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove MOS power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of TMOS RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF172 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF172 was characterized at $I_{DQ} = 50$ mA, which is the

suggested minimum value of I_{DQ} . For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF172 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC, and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF172. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of TMOS FETs helps ease the task of broadband network design. Both small-signal scattering parameters and large-signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of TMOS power FETs.

FIGURE 18 — 150 MHz TEST CIRCUIT

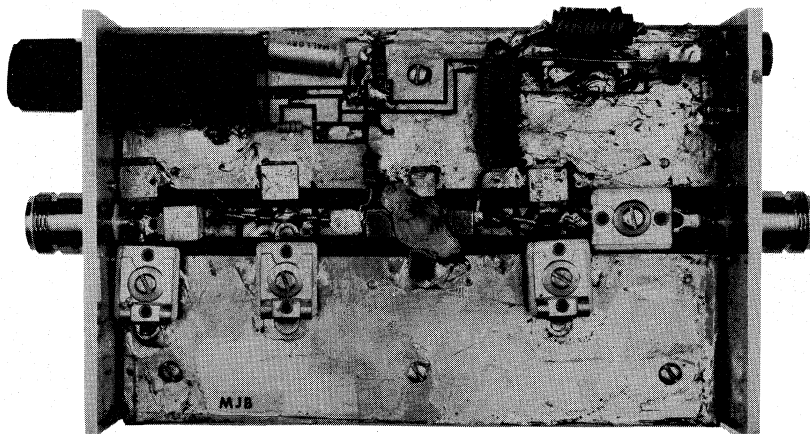
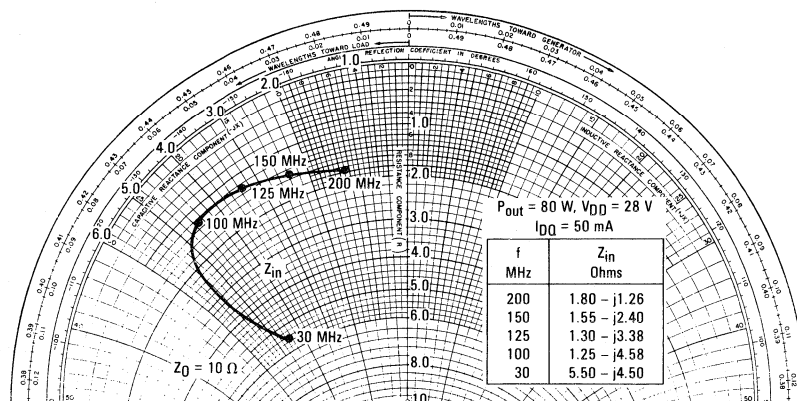
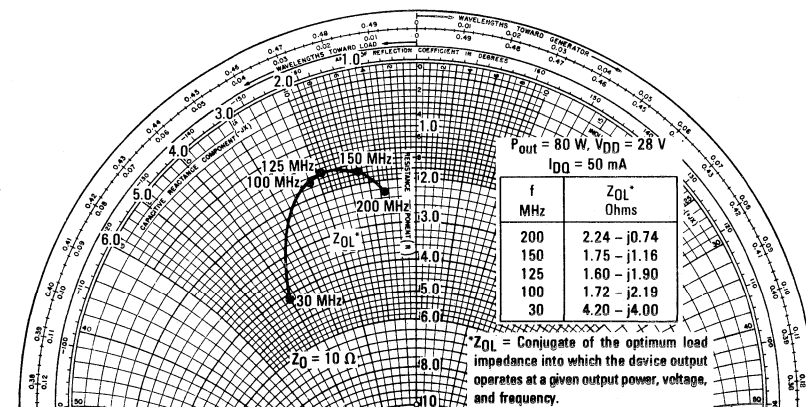


FIGURE 19 — SERIES EQUIVALENT INPUT IMPEDANCE, Z_{in} FIGURE 20 — SERIES EQUIVALENT OUTPUT IMPEDANCE, Z_{OL}^* 

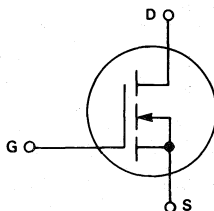
MRF174

The RF TMOS Line

**N-CHANNEL ENHANCEMENT-MODE
 TMOS RF POWER FIELD-EFFECT TRANSISTOR**

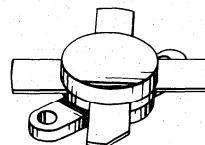
... designed primarily for wideband large-signal output and driver stages in the 2.0-200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
 - Output Power = 125 Watts
 - Minimum Gain = 9.0 dB
 - Efficiency = 50% (Min)
- Excellent Thermal Stability, Ideally Suited for Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 3.0 dB Typ at 2.0 A, 150 MHz



125 W 2.0-200 MHz

**N-CHANNEL TMOS
 BROADBAND RF POWER
 FET**



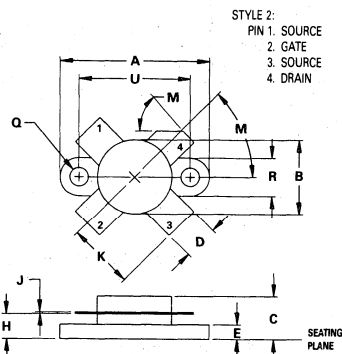
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	65	Vdc
Drain — Gate Voltage ($R_{GS} = 1.0 \text{ M}\Omega$)	V_{DGR}	65	Vdc
Gate — Source Voltage	V_{GS}	± 40	Vdc
Drain Current — Continuous	I_D	13	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	270 1.54	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	$^\circ\text{C}/\text{W}$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.96	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM	—	45° NOM	—
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 50$ mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 28$ V, $V_{GS} = 0$)	I_{DSS}	—	—	10	mA _{dc}
Gate-Source Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	—	1.0	μA_{dc}
ON CHARACTERISTICS					
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 100$ mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 3.0$ A)	g_{fs}	1.75	2.5	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{iss}	—	175	—	pF
Output Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{oss}	—	230	—	pF
Reverse Transfer Capacitance ($V_{DS} = 28$ V, $V_{GS} = 0$, $f = 1.0$ MHz)	C_{rss}	—	40	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure ($V_{DD} = 28$ Vdc, $I_D = 2.0$ A, $f = 150$ MHz)	NF	—	3.0	—	dB
Common Source Power Gain ($V_{DD} = 28$ Vdc, $P_{out} = 125$ W, $f = 150$ MHz, $I_{DQ} = 100$ mA)	G_{ps}	9.0	11.8	—	dB
Drain Efficiency ($V_{DD} = 28$ Vdc, $P_{out} = 125$ W, $f = 150$ MHz, $I_{DQ} = 100$ mA)	η	50	60	—	%
Electrical Ruggedness ($V_{DD} = 28$ Vdc, $P_{out} = 125$ W, $f = 150$ MHz, $I_{DQ} = 100$ mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

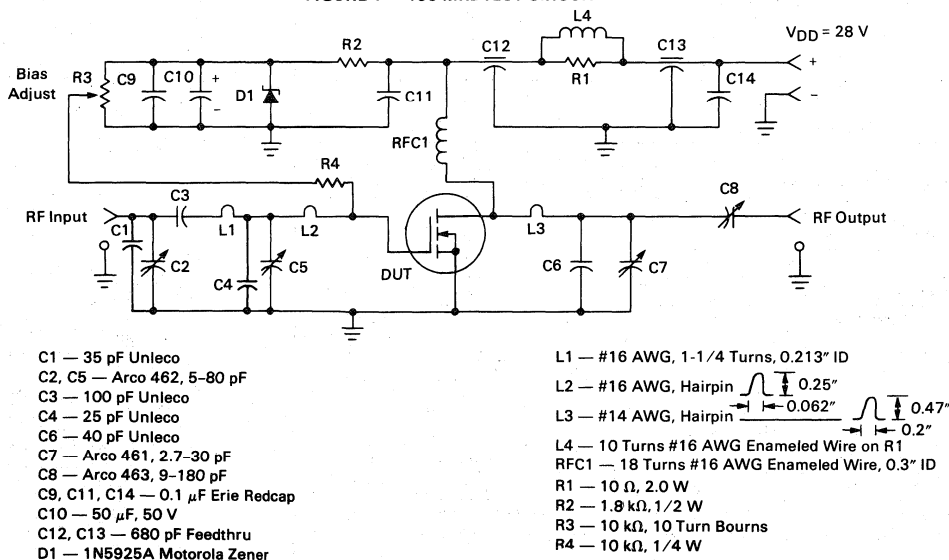
FIGURE 1 — 150 MHz TEST CIRCUIT

FIGURE 2 — OUTPUT POWER versus INPUT POWER

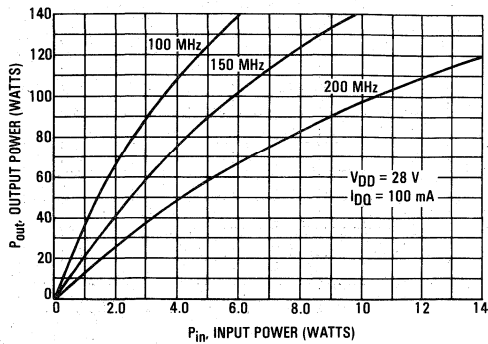


FIGURE 3 — OUTPUT POWER versus INPUT POWER

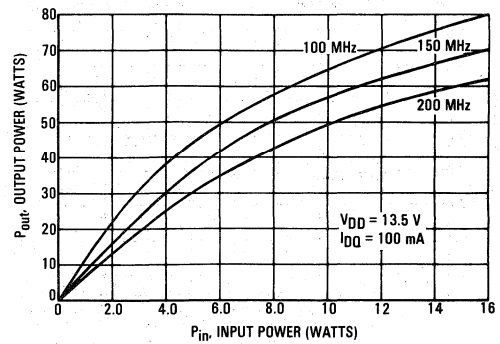
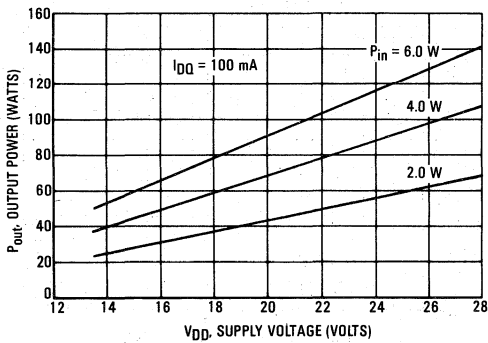
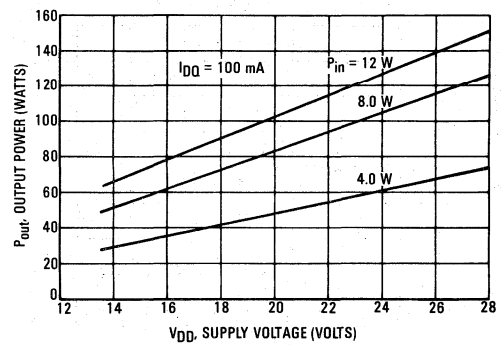
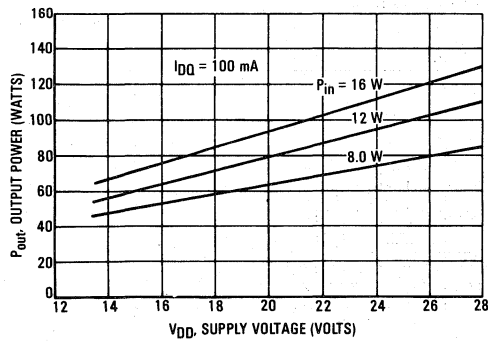
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 100\text{ MHz}$ FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 150\text{ MHz}$ FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 200\text{ MHz}$ 

FIGURE 7 — POWER GAIN versus FREQUENCY

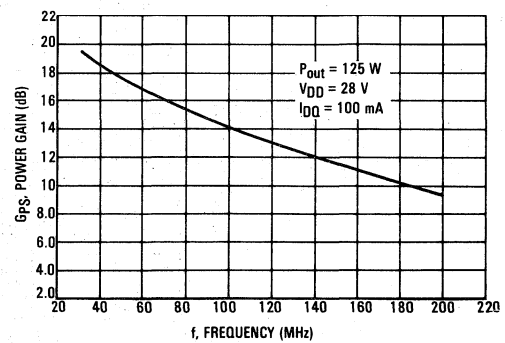


FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

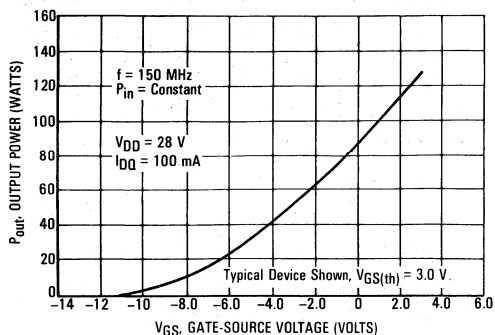


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

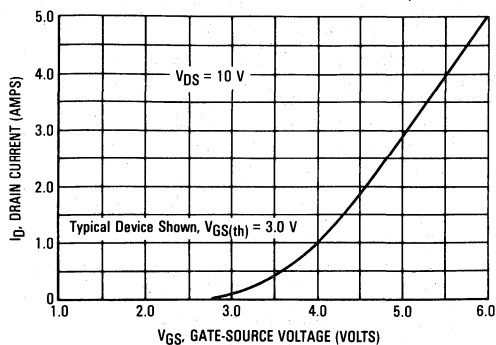


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

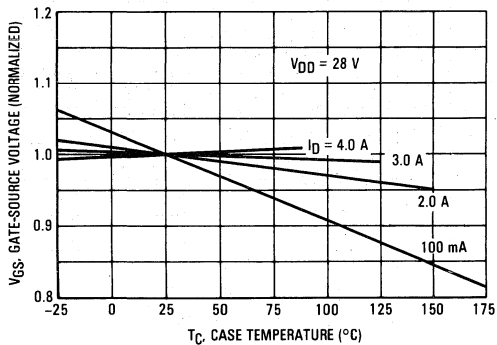


FIGURE 11 — CAPACITANCE versus DRAIN VOLTAGE

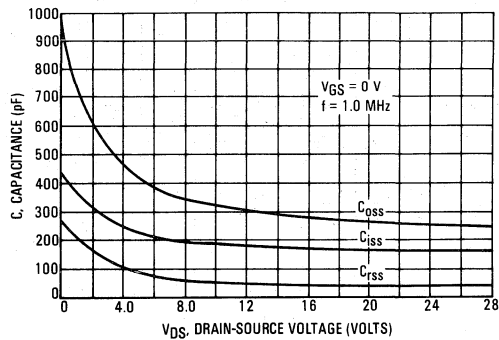


FIGURE 12 — DC SAFE OPERATING AREA

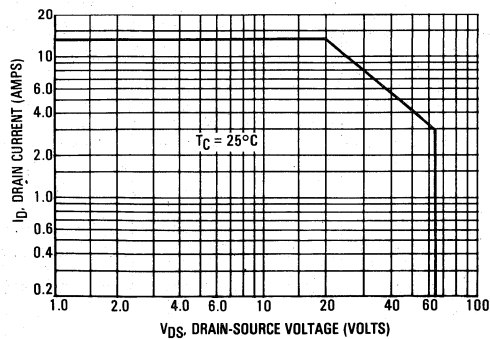
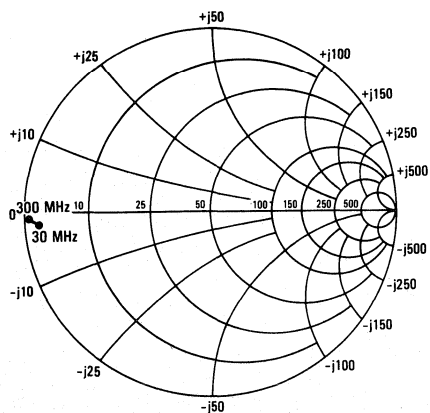


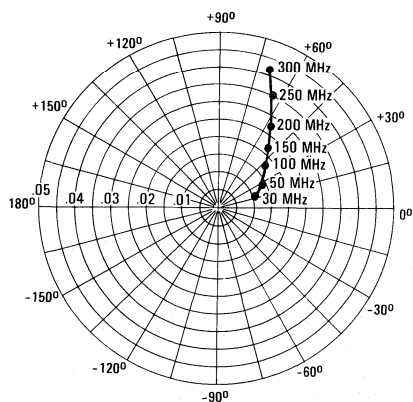
FIGURE 13 — COMMON SOURCE SCATTERING PARAMETERS
 $V_{DS} = 28 \text{ V}$, $I_D = 3.0 \text{ A}$

f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
	|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
2.0	0.932	-133	74.0	112	0.011	23	0.835	-151
5.0	0.923	-160	31.6	98	0.011	12	0.886	-168
10	0.921	-170	16.0	93	0.011	10	0.896	-174
20	0.921	-175	8.00	88	0.011	12	0.899	-177
30	0.921	-177	5.32	86	0.011	16	0.900	-178
40	0.921	-177	3.98	83	0.012	21	0.901	-178
50	0.922	-178	3.17	81	0.012	26	0.902	-178
60	0.923	-178	2.63	79	0.012	30	0.903	-178
70	0.924	-178	2.24	77	0.013	34	0.904	-178
80	0.925	-178	1.95	75	0.013	39	0.906	-178
90	0.927	-178	1.72	73	0.014	43	0.907	-178
100	0.930	-178	1.50	71	0.016	45	0.910	-178
110	0.930	-178	1.31	70	0.018	46	0.912	-178
120	0.931	-178	1.19	68	0.019	47	0.914	-178
130	0.942	-178	1.10	67	0.019	49	0.919	-178
140	0.936	-178	1.01	66	0.021	50	0.921	-178
150	0.938	-178	0.936	65	0.021	53	0.922	-178
160	0.938	-178	0.879	64	0.022	53	0.923	-178
170	0.940	-178	0.830	63	0.023	54	0.923	-177
180	0.942	-178	0.780	61	0.024	56	0.924	-177
190	0.942	-178	0.737	60	0.026	59	0.928	-177
200	0.952	-178	0.705	59	0.027	58	0.929	-177
210	0.950	-178	0.668	57	0.029	61	0.934	-177
220	0.942	-178	0.626	56	0.030	61	0.933	-177
230	0.943	-178	0.592	56	0.032	62	0.939	-177
240	0.946	-177	0.566	55	0.033	64	0.941	-177
250	0.952	-177	0.545	54	0.035	64	0.943	-177
260	0.958	-177	0.523	53	0.036	65	0.946	-177
270	0.956	-177	0.500	52	0.038	67	0.943	-177
280	0.960	-177	0.481	52	0.039	68	0.946	-177
290	0.956	-178	0.460	51	0.042	68	0.944	-177
300	0.955	-178	0.443	50	0.043	68	0.947	-177

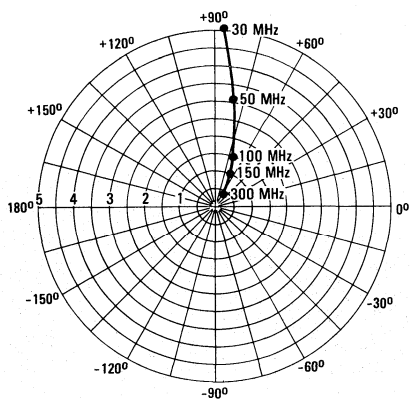
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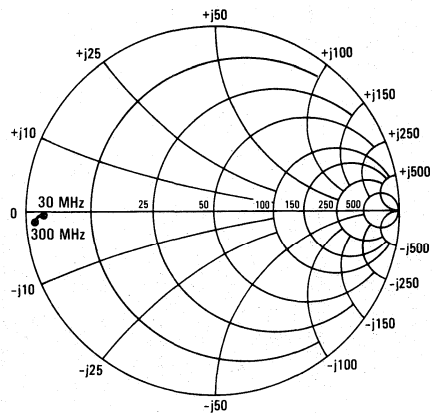
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versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 3.0 \text{ A}$



**FIGURE 17 — S_{22} , OUTPUT REFLECTION COEFFICIENT
versus FREQUENCY**
 $V_{DS} = 28 \text{ V}$ $I_D = 3.0 \text{ A}$



DESIGN CONSIDERATIONS

The MRF174 is a TMOS RF power N-channel enhancement mode field-effect transistor (FET) designed for VHF power amplifier applications. Motorola TMOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove MOS power FETs.

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The major advantages of TMOS RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF174 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF174 was characterized at $I_{DQ} = 100$ mA, which is the

suggested minimum value of I_{DQ} . For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF174 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC, and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF174. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of TMOS FETs helps ease the task of broadband network design. Both small-signal scattering parameters and large-signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of TMOS power FETs.

FIGURE 18 — 150 MHz TEST CIRCUIT

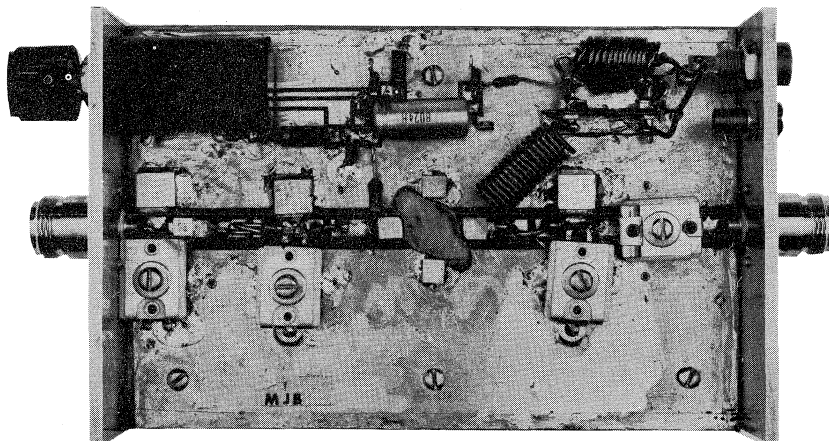
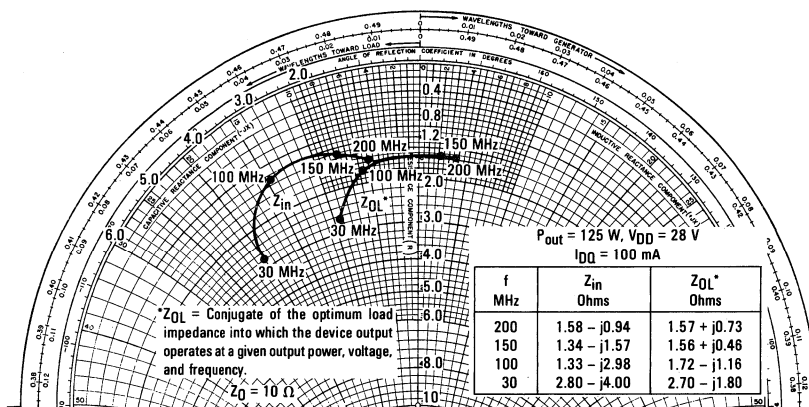


FIGURE 19 — SERIES EQUIVALENT INPUT AND OUTPUT IMPEDANCE, Z_{in} , Z_{OL}^* 

The RF Line

NPN Silicon

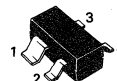
High-Frequency Transistor

... designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching times.

- High Current-Gain-Bandwidth Product — $f_T = 5.5$ GHz (Typ) @ $I_C = 40$ mAdc
- Low Noise Figure @ $f = 1$ GHz — $NF_{(matched)} = 1.8$ dB (Typ)
- High Power Gain — $G_{pe (matched)} = 13$ dB (Typ)
- Surface Mount SOT-143 Offers Improved RF Performance
 - Lower Package Parasitics
 - Higher Gain
- Available In Both Standard and Low Profile Packages
- Tape and Reel Packaging Options
- Higher Voltage Version of MRF5711
- Electrically Similar to NEC NE 02133

MRF0211
MRF0211L

SURFACE MOUNT
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



SOT-143
CASE 318B-03, STYLE 1
STANDARD PROFILE
MRF0211

CASE 318A-04, STYLE 1
LOW PROFILE
MRF0211L

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	0.58 4.64	Watts mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ (Note 1) Derate above 75°C	P_D	0.58 7.73	Watts mW/ $^\circ\text{C}$
Maximum Junction Temperature	T_{Jmax}	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	216	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	130	$^\circ\text{C/W}$

DEVICE MARKING

MRF0211 = 15

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 50$ μ Adc, $I_C = 0$)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$)	I_{CBO}	—	—	10	μ Adc

Note 1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

ON CHARACTERISTICS

DC Current Gain ($I_C = 30\text{ mA}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	50	—	300	—
---	----------	----	---	-----	---

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	Figure 1	C_{cb}	—	0.7	1	pF
Current Gain — Bandwidth Product ($V_{CE} = 10\text{ Vdc}$, $I_C = 40\text{ mA}$, $f = 1\text{ GHz}$)	Figure 7	f_T	—	5.5	—	GHz

FUNCTIONAL TESTS

Gain at Noise Figure (Tuned) ($V_{CE} = 10\text{ Vdc}$, $I_C = 5\text{ mA}$)	Figure 4 $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$	GNF_{min}	— —	19 13	— —	dB
Noise Figure (Tuned) ($V_{CE} = 10\text{ Vdc}$, $I_C = 5\text{ mA}$)	Figure 4 $f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$ $f = 2\text{ GHz}$	NF_{min}	— — —	0.9 1.8 3	— — —	dB
Power Gain in $50\ \Omega$ System ($V_{CE} = 10\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 2	GNF	—	9.5	—	dB
Noise Figure in $50\ \Omega$ System ($V_{CE} = 10\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 2	NF	—	2.7	3	dB
Insertion Gain ($V_{CE} = 10\text{ Vdc}$, $I_C = 25\text{ mA}$, $f = 1\text{ GHz}$)		S_{21}^2	11	13.5	—	dB
Maximum Unilateral Gain ($V_{CE} = 10\text{ Vdc}$, $I_C = 25\text{ mA}$, $f = 1\text{ GHz}$)		G_{Umax}	—	15.5	—	dB

TYPICAL CHARACTERISTICS

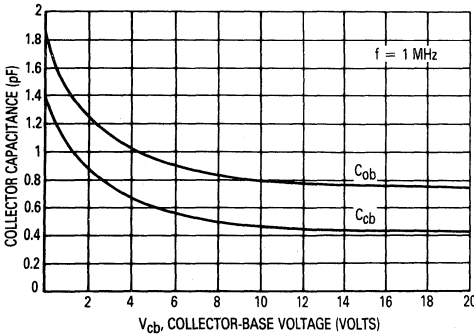


Figure 1. Device Capacitances versus Voltage

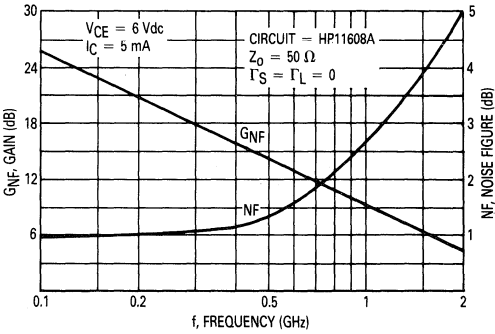


Figure 2. Gain and Noise Figure versus Frequency

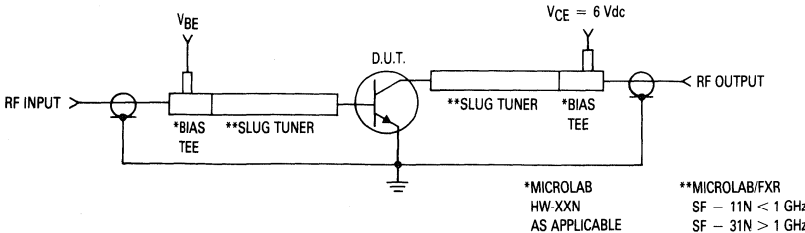


Figure 3. Functional Circuit Schematic

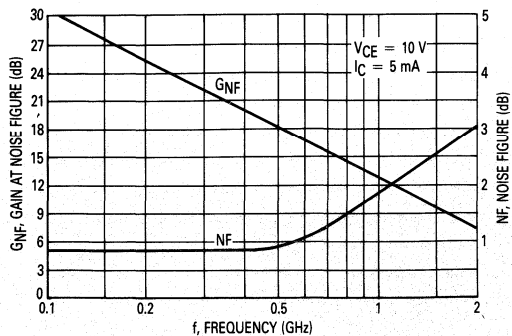


Figure 4. Gain at Noise Figure and Noise Figure versus Frequency

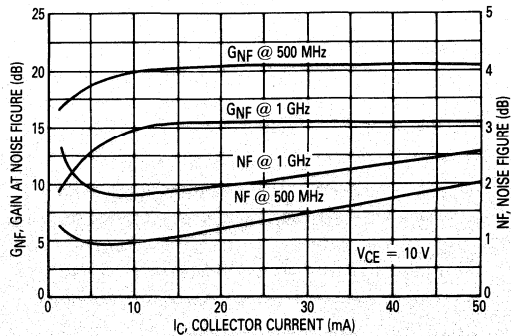


Figure 5. Gain at Noise Figure and Noise Figure versus Collector Current

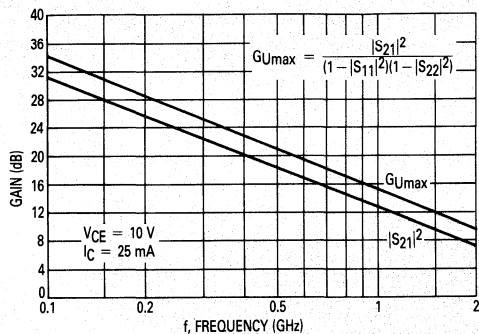


Figure 6. Unilateral-Gain and Insertion Gain versus Frequency

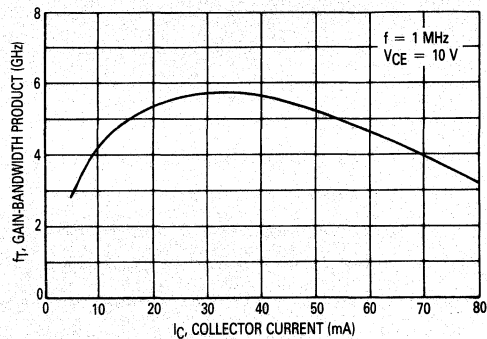


Figure 7. Gain-Bandwidth Product versus Collector Current

COMMON EMITTER S-PARAMETERS

V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
5	5	100	0.84	-50	13.2	151	0.04	64	0.90	-22
		200	0.81	-87	10.4	130	0.06	49	0.74	-35
		500	0.74	-139	5.6	100	0.07	32	0.50	-48
		1000	0.68	-175	2.9	77	0.09	32	0.42	-58
		1500	0.66	167	2	61	0.09	40	0.44	-67
		2000	0.65	149	1.5	51	0.11	51	0.44	-73
	10	100	0.76	-66	20.6	144	0.03	60	0.83	-32
		200	0.73	-106	14.8	122	0.05	44	0.62	-49
		500	0.69	-153	7.1	96	0.06	37	0.36	-63
		1000	0.65	178	3.7	76	0.08	44	0.28	-71
		1500	0.62	162	2.5	63	0.09	51	0.30	-77
		2000	0.61	145	1.9	54	0.12	59	0.20	-78
	25	100	0.65	-89	28.8	134	0.03	55	0.71	-44
		200	0.67	-126	18.2	114	0.04	45	0.48	-64
		500	0.65	-163	8.3	92	0.05	45	0.27	-80
		1000	0.63	172	4.2	76	0.07	55	0.20	-90
		1500	0.60	158	2.8	64	0.10	60	0.22	-92
		2000	0.59	142	2.2	55	0.13	63	0.20	-90
	50	100	0.62	-110	30.4	126	0.02	51	0.62	-49
		200	0.66	-142	18.0	109	0.03	45	0.41	-65
		500	0.66	-171	7.9	90	0.04	52	0.25	-79
		1000	0.64	168	4.1	75	0.06	62	0.20	-91
		1500	0.62	155	2.7	62	0.10	65	0.20	-93
		2000	0.60	140	2.1	55	0.13	67	0.14	-90
10	5	100	0.86	-46	13.2	153	0.03	69	0.92	-18
		200	0.82	-81	10.6	132	0.05	51	0.80	-28
		500	0.72	-134	5.9	102	0.07	36	0.57	-38
		1000	0.65	-171	3.2	78	0.08	38	0.49	-46
		1500	0.63	169	2.1	62	0.08	47	0.52	-55
		2000	0.61	149	1.6	51	0.10	60	0.53	-61
	10	100	0.77	-60	20.7	145	0.03	62	0.85	-26
		200	0.72	-98	15.2	124	0.04	48	0.66	-38
		500	0.65	-147	7.5	97	0.06	42	0.44	-46
		1000	0.59	-177	3.9	77	0.07	48	0.37	-51
		1500	0.58	165	2.6	64	0.09	56	0.39	-59
		2000	0.56	145	2	54	0.13	65	0.40	-62
	25	100	0.67	-80	29.4	136	0.02	57	0.75	-35
		200	0.66	-118	19.3	116	0.03	47	0.53	-48
		500	0.63	-158	8.9	94	0.05	47	0.33	-55
		1000	0.61	175	4.6	77	0.07	57	0.26	-60
		1500	0.58	161	3.1	64	0.09	61	0.29	-65
		2000	0.57	144	2.3	55	0.12	66	0.30	-65
	50	100	0.65	-99	32.2	129	0.02	54	0.67	-38
		200	0.65	-135	19.5	110	0.03	44	0.45	-48
		500	0.64	-167	8.5	91	0.04	53	0.31	-51
		1000	0.61	170	4.2	75	0.06	62	0.26	-55
		1500	0.59	157	2.9	63	0.09	58	0.30	-61
		2000	0.58	141	2.3	54	0.11	71	0.31	-63

MRF226

The RF Line

NPN SILICON RF POWER TRANSISTOR

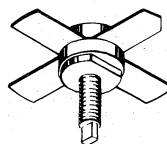
... designed for 12.5 Volt large-signal power amplifier applications in communication equipment operating at 225 MHz.

- Specified 12.5 Volt, 225 MHz Characteristics —
Output Power = 13 Watts
Minimum Gain = 9.0 dB
Efficiency = 50%
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Designed to Withstand Load Mismatch at all Phase Angles with 20:1 VSWR

13 W — 225 MHz

RF POWER
TRANSISTOR

NPN SILICON



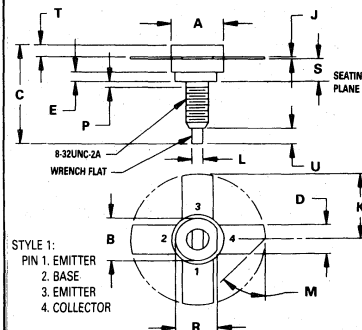
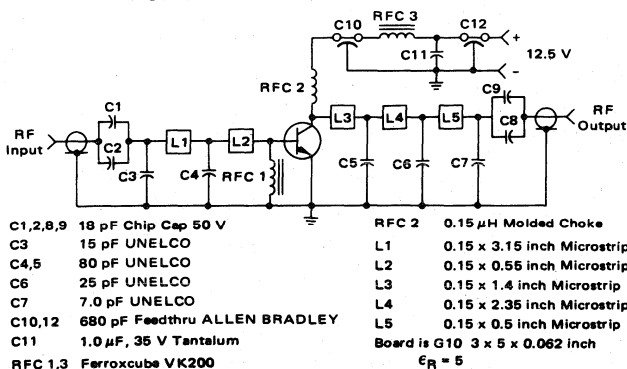
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	45 257	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Stud Torque (2)	—	6.5	In. Lb.

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF amplifier.

(2) For repeated assembly, use 5 In. Lb.

FIGURE 1 — 225 MHz TEST CIRCUIT SCHEMATIC



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

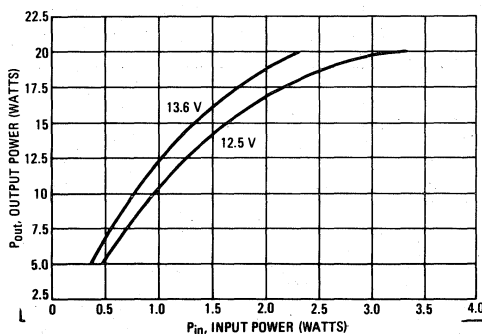
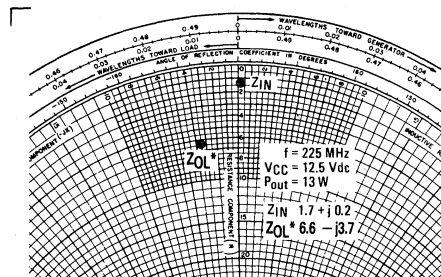
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM	45° NOM	—	—
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 15\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	18	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	0.25	mAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 250\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—
FUNCTIONAL TEST (Figure 1)				
Common-Emitter Amplifier Power Gain ($P_{out} = 13\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 225\text{ MHz}$)	G_{pE}	9.0	—	dB
Collector Efficiency ($P_{out} = 13\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 225\text{ MHz}$)	η	50	—	%

FIGURE 2 – OUTPUT POWER versus INPUT POWER**FIGURE 3 – SERIES EQUIVALENT IMPEDANCE**

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MRF227

The RF Line

NPN SILICON RF POWER TRANSISTOR

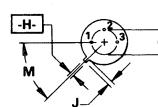
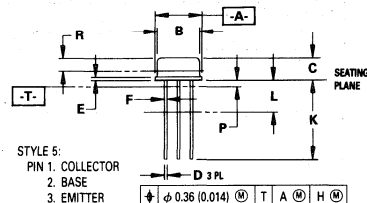
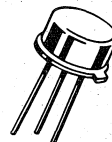
... designed for 12.5 Volt large-signal power amplifier applications in communication equipment operating at 225 MHz. Ideally suited for Class E citizens band radio.

- Specified 12.5 Volt, 225 MHz Characteristics —
Output Power = 3.0 Watts
Minimum Gain = 13.5 dB
Efficiency = 60%
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Grounded Emitter TO-206AF (TO-39) Package for High Gain and Excellent Heat Dissipation
- Replaces Medium Power Stud Mount Devices

3 W — 225 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
 4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
 5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-05
TO-206AF
(TO-39)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Collector Current — Continuous	I_C	600	mA dc
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	8.0 46	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 55^\circ\text{C}$)	I_{CES}	—	—	10	mA
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	—	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	15	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($P_{out} = 3.0\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 225\text{ MHz}$)	G_{pE}	13.5	15	—	dB
Collector Efficiency ($P_{out} = 3.0\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 225\text{ MHz}$)	η	60	—	—	%

FIGURE 1 — 225 MHz TEST CIRCUIT

C1,C2,C3,C4 ARCO 420
C5 1000 pF, UNELCO
C6 0.047 pF, ERIE
C7 1.0 pF, TANTALUM
L1 #18 AWG, 1" Wire Length
L2 VK200-4 Ferroxcube
L3 1 Turn, #18 AWG, 1/4" ID x 2" Wire Length
L4 0.15 μH DELEVAN Molded Choke
Board — Glass Teflon, $\epsilon_R = 2.56$, $t = 0.062"$
Input/Output Connectors — Type N

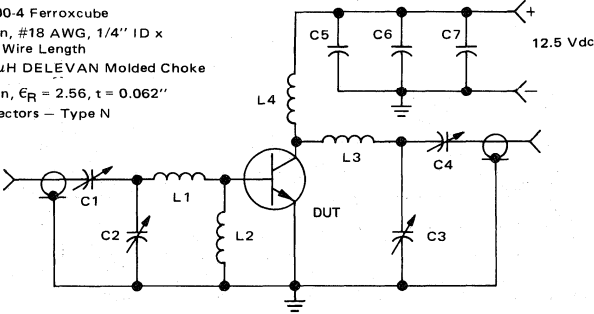


FIGURE 2 – INPUT POWER versus OUTPUT POWER – 12.5 V

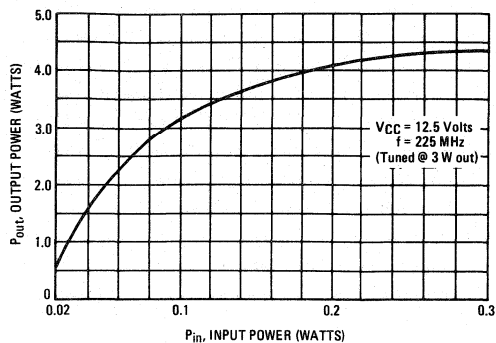


FIGURE 3 – INPUT POWER versus OUTPUT POWER – 13.6 V

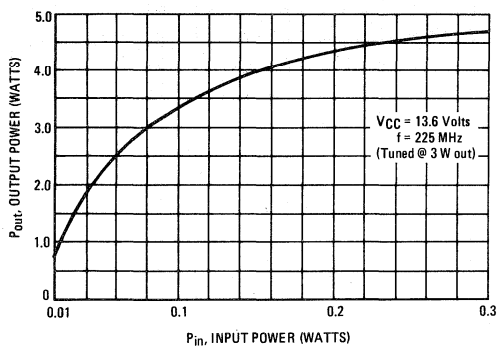


FIGURE 4 – INPUT POWER versus OUTPUT POWER – 7.5 V

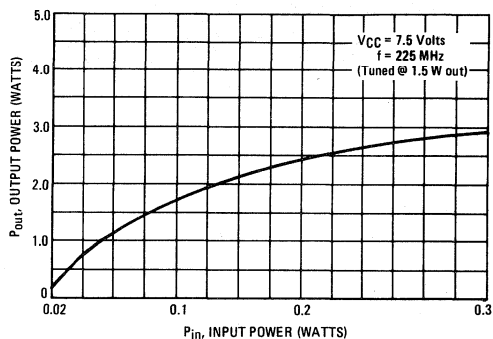


FIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE

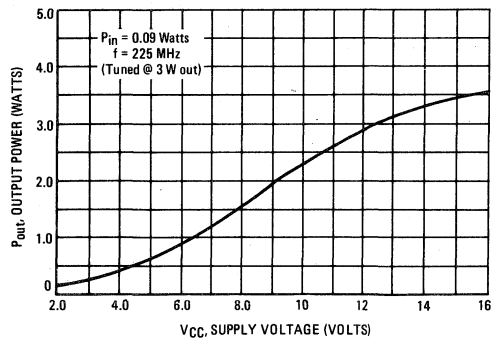
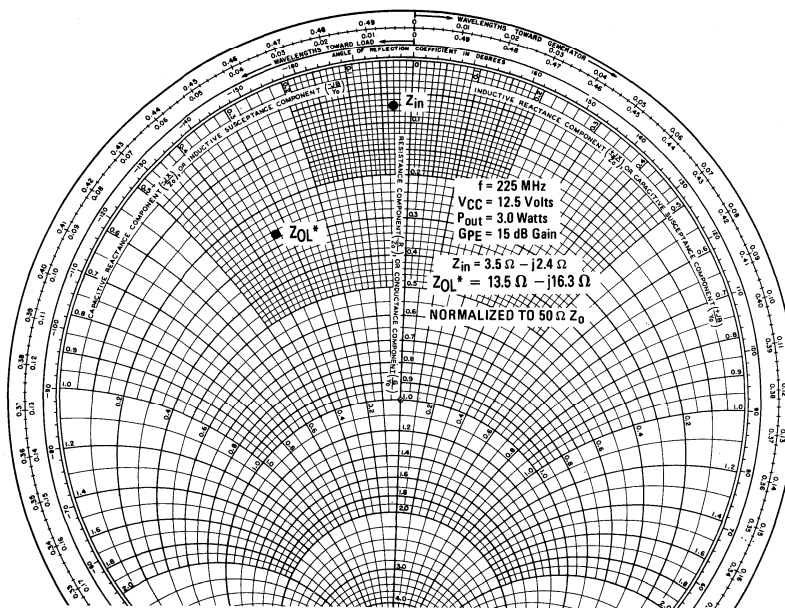


FIGURE 6 — SERIES EQUIVALENT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

- Specified 12.5 Volt, 90 MHz Characteristics —
 Output Power = 1.5 Watts
 Minimum Gain = 10 dB
 Efficiency = 55%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Characterized with Parallel Equivalent Large-Signal Impedance Parameters
- MRF229 — Emitter Connected to Case

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1). Derate above 25°C	P_D	5.0 28.6	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

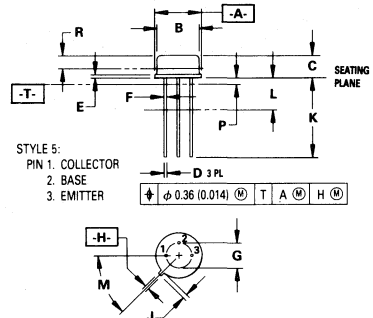
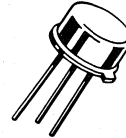
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R\theta_{JC}$	35	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF Amplifier.

MRF229

1.5 W — 90 MHz
 RF POWER
 TRANSISTOR
 NPN SILICON



- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 - CONTROLLING DIMENSION: INCH.
 - DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
 - DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
 - DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-05
 TO-206AF
 (TO-39)

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.25\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	0.5	mA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 250\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—
DYNAMIC CHARACTERISTICS				
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	25	pF
FUNCTIONAL TESTS (Figure 1)				
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.5\text{ W}$, $f = 90\text{ MHz}$)	GPE	10	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.5\text{ W}$, $f = 90\text{ MHz}$)	η	55	—	%
Load Mismatch ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.5\text{ W}$, $f = 90\text{ MHz}$, $T_C \leq 25^\circ\text{C}$)	—	No Degradation in Output Power		

FIGURE 1 — 90 MHz TEST CIRCUIT SCHEMATIC

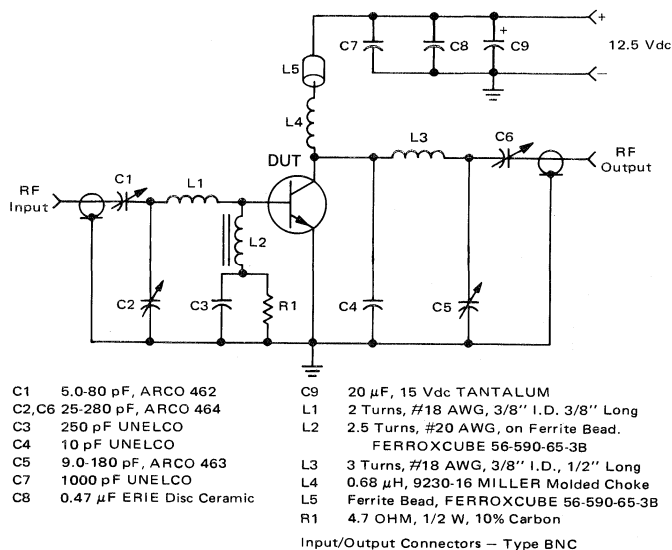


FIGURE 2 – OUTPUT POWER versus INPUT POWER

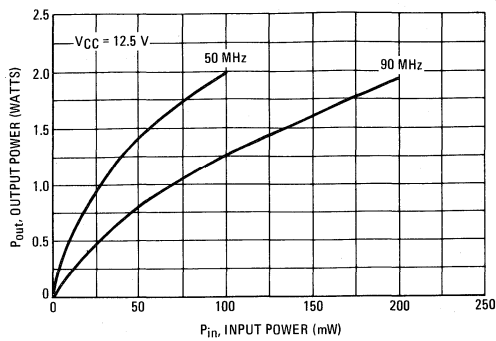


FIGURE 3 – OUTPUT POWER versus FREQUENCY

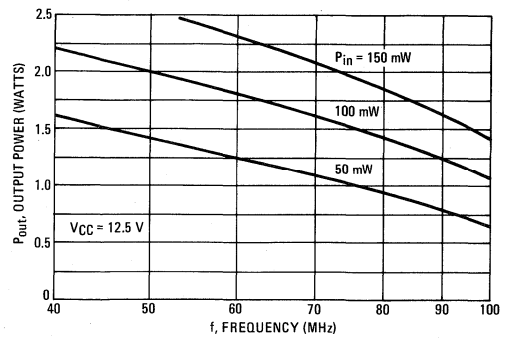


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

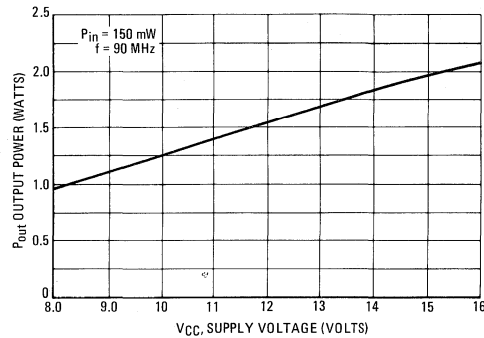
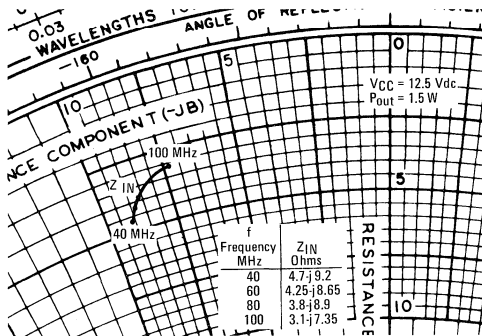
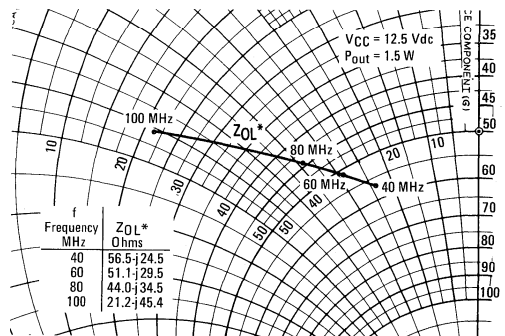


FIGURE 5

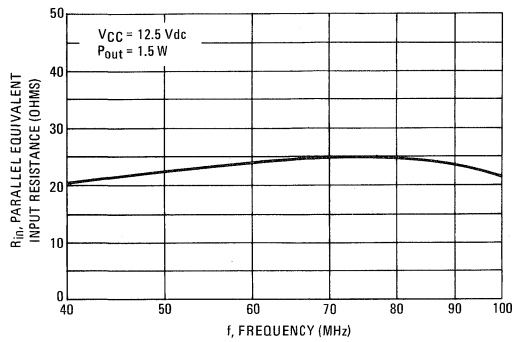
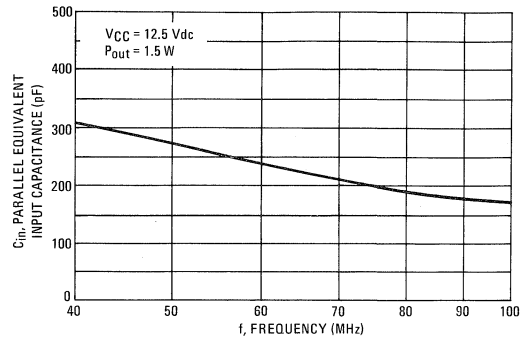
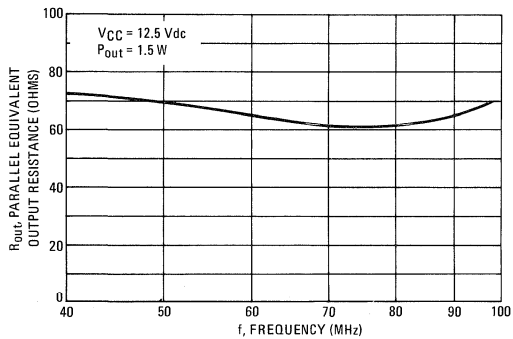
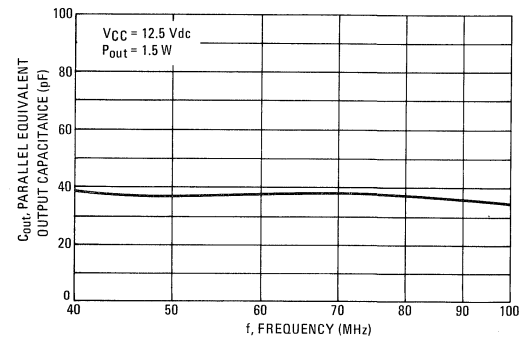
SERIES EQUIVALENT INPUT IMPEDANCE



SERIES EQUIVALENT OUTPUT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

**FIGURE 6 – PARALLEL EQUIVALENT INPUT RESISTANCE
versus FREQUENCY****FIGURE 7 – PARALLEL EQUIVALENT INPUT CAPACITANCE
versus FREQUENCY****FIGURE 8 – PARALLEL EQUIVALENT OUTPUT RESISTANCE
versus FREQUENCY****FIGURE 9 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE
versus FREQUENCY**

MRF232

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

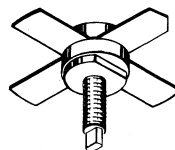
- Specified 12.5 Volt, 90 MHz Characteristics —
Output Power = 7.5 Watts
Minimum Gain = 9.0 dB
Efficiency = 55%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Characterized with Parallel Equivalent Large-Signal Impedance Parameters

7.5 W — 90 MHz

**RF POWER
TRANSISTOR**

NPN SILICON

2



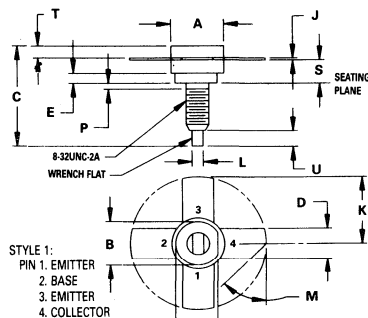
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	20 114	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Stud Torque (2)	—	6.5	In. Lb.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	8.75	$^\circ\text{C/W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF Amplifier.
(2) For repeated assembly use 5 In. Lb.



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

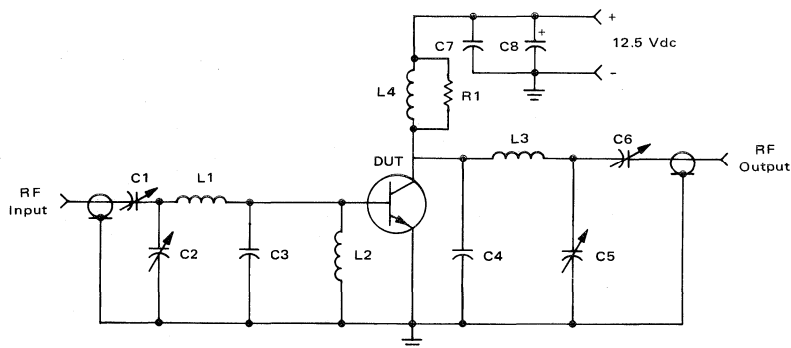
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM	45° NOM	—	—
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	18	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	1.0	mA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	—
DYNAMIC CHARACTERISTICS				
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	55	pF
FUNCTIONAL TESTS (Figure 1)				
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 7.5\text{ W}$, $f = 90\text{ MHz}$)	G_{PE}	9.0	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 7.5\text{ W}$, $f = 90\text{ MHz}$)	η	55	—	%
Load Mismatch ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 7.5\text{ W}$, $f = 90\text{ MHz}$, $T_C \leq 25^\circ\text{C}$)	—	No Degradation in Output Power		

FIGURE 1 — 90 MHz TEST CIRCUIT SCHEMATIC

C1,C6 5.0-80 pF, ARCO 462
 C2,C5 9.0-180 pF, ARCO 463
 C3,C4 100 pF UNELCO
 C7 1000 pF UNELCO
 C8 4.7 μF , 15 Vdc, TANTALUM

L1 3 Turns, #18 AWG, 3/8" I.D., 3/8" Long
 L2 FERROXCUBE VK200-20-4B Ferrite Choke
 L3 3 Turns, #18 AWG, 5/16" I.D., 3/8" Long
 L4 10 Turns, #22 AWG, on R1
 R1 340 Ohm, 1 W Carbon
 Input/Output Connectors — Type BNC

FIGURE 2 – OUTPUT POWER versus INPUT POWER

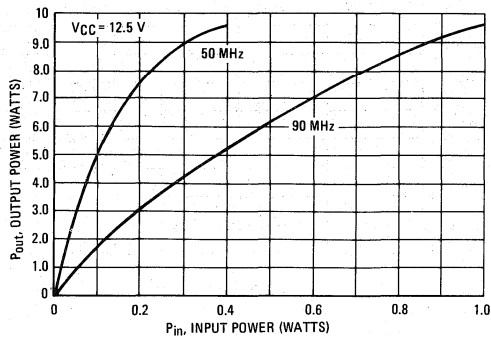


FIGURE 3 – OUTPUT POWER versus FREQUENCY

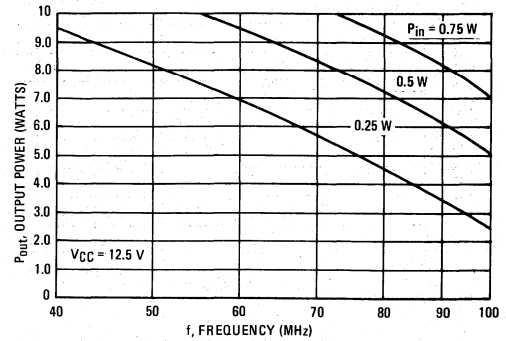


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

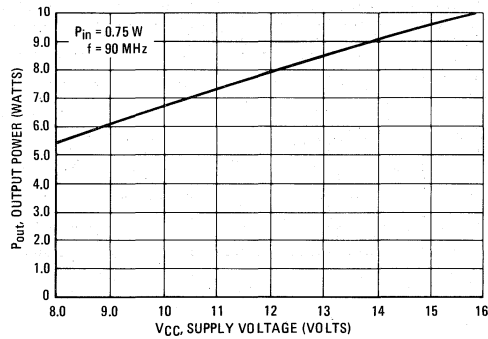
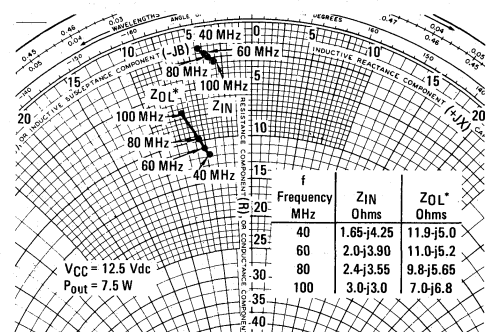
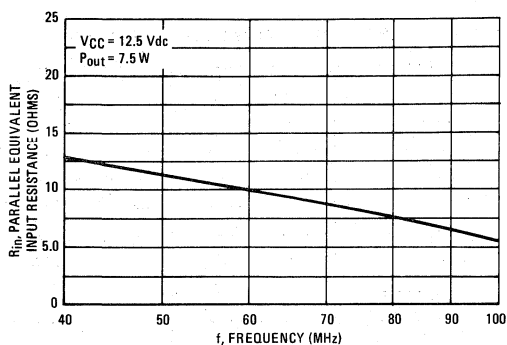
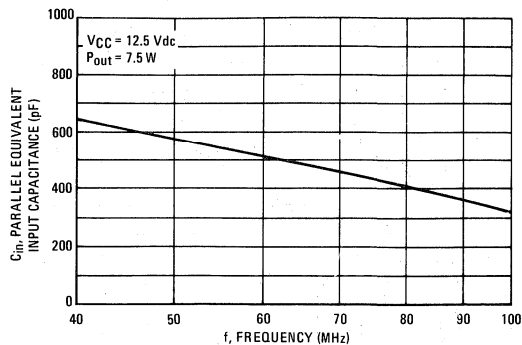
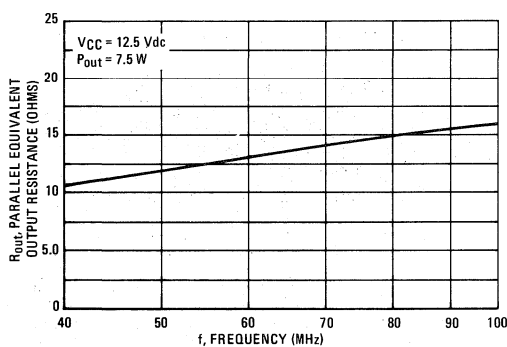
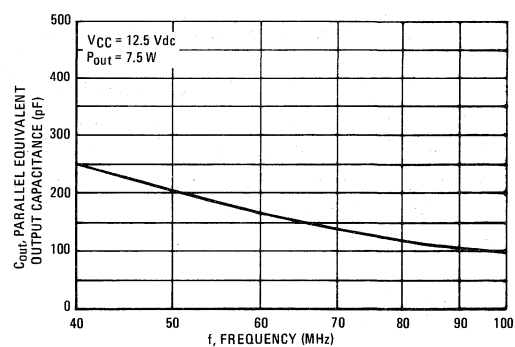


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

**FIGURE 6 – PARALLEL EQUIVALENT INPUT RESISTANCE
versus FREQUENCY****FIGURE 7 – PARALLEL EQUIVALENT INPUT CAPACITANCE
versus FREQUENCY****FIGURE 8 – PARALLEL EQUIVALENT OUTPUT RESISTANCE
versus FREQUENCY****FIGURE 9 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE
versus FREQUENCY**

MRF233

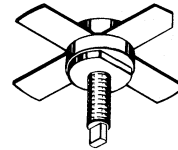
The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

- Specified 12.5 Volt, 90 MHz Characteristics —
Output Power = 15 Watts
Minimum Gain = 10 dB
Efficiency = 55%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Characterized with Parallel Equivalent Large-Signal Impedance Parameters

15 W — 90 MHz
RF POWER TRANSISTOR
NPN SILICON



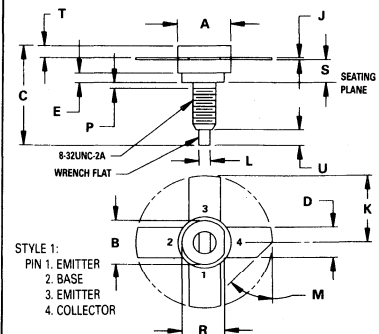
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	18	V _{dc}
Collector-Base Voltage	V _{CB0}	36	V _{dc}
Emitter-Base Voltage	V _{EB0}	4.0	V _{dc}
Collector Current — Continuous	I _C	3.5	A _{dc}
Total Device Dissipation @ T _C = 25°C (1) Derate Above 25°C	P _D	50 285	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C
Stud Torque (2)	—	6.5	In-lb

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R _{θJC}	3.5	°C/W

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF Amplifier.
(2) For repeated assembly use 5 In. Lb.



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

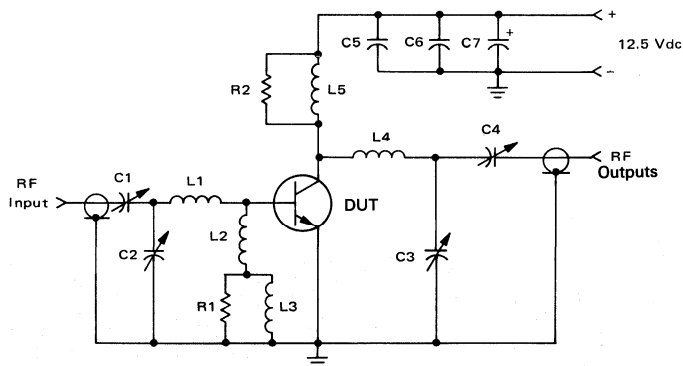
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	100	120	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 90\text{ MHz}$)	G_{pE}	10	—	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 90\text{ MHz}$)	η	55	—	—	%
Load Mismatch ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 90\text{ MHz}$, $T_C \leq 25^\circ\text{C}$)	—	No Degradation in Output Power			

FIGURE 1 – 90 MHz TEST CIRCUIT SCHEMATIC



C1, C3 9.0-180 pF, ARCO 463

C2, C4 25-280 pF ARCO 464

C5 1000 pF UNELCO

C6 0.01 μF ERIE Disc CeramicC7 1.0 μF , 35 Vdc TANTALUM

L1 2 Turns, #18 AWG, 3/8" I.D., 1/4" Long

L2 0.22 μH , 9230-04 MILLER Molded ChokeL3 2.2 μH , 9230-200 MILLER Molded Choke

L4 2 Turns, #18 AWG, 3/8" I.D., 3/8" Long

L5 10 Turns, #16 AWG, Wound On R2.

R1 15 Ohm, 1/2 W, 10% Carbon

R2 68 Ohm, 1 Watt, 10% Carbon

Input/Output Connectors – Type BNC

FIGURE 2 – OUTPUT POWER versus INPUT POWER

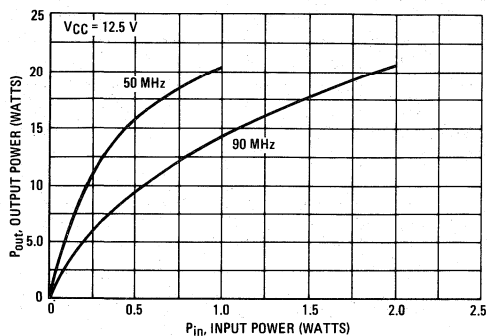


FIGURE 3 – OUTPUT POWER versus FREQUENCY

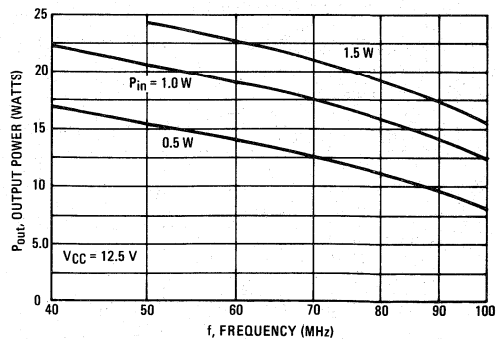


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

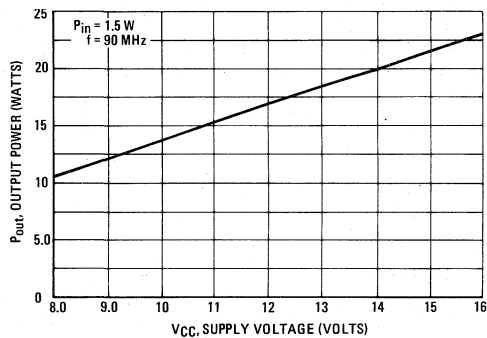
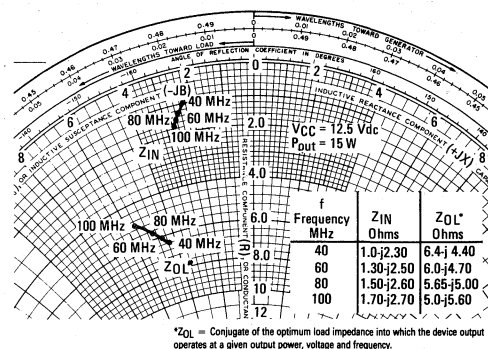
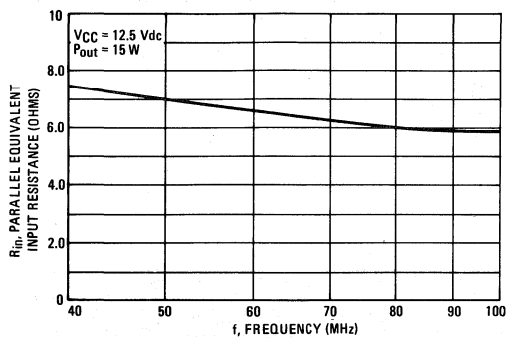
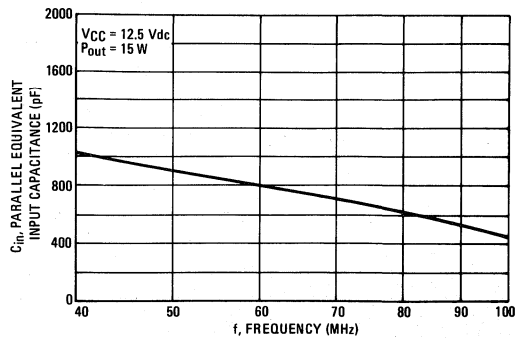
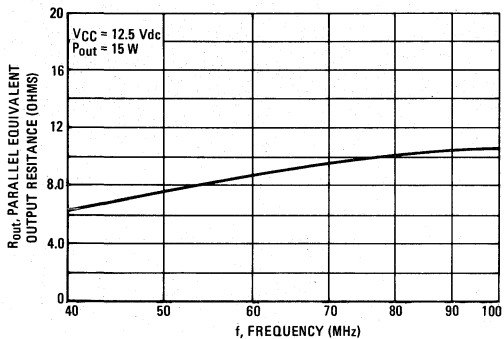
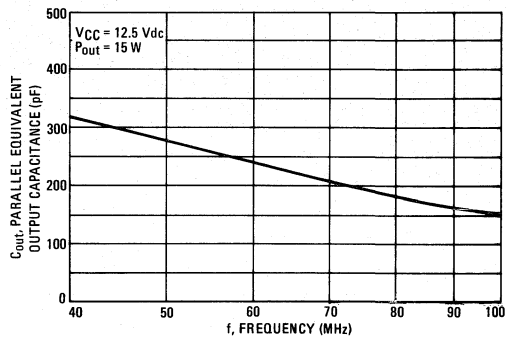


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



**FIGURE 6 – PARALLEL EQUIVALENT INPUT RESISTANCE
versus FREQUENCY****FIGURE 7 – PARALLEL EQUIVALENT INPUT CAPACITANCE
versus FREQUENCY****FIGURE 8 – PARALLEL EQUIVALENT OUTPUT RESISTANCE
versus FREQUENCY****FIGURE 9 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE
versus FREQUENCY**

MRF234

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

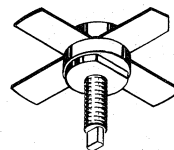
- Specified 12.5 Volt, 90 MHz Characteristics —
Output Power = 25 Watts
Minimum Gain = 9.5 dB
Efficiency = 55%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR.
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Characterized with Parallel Equivalent Large-Signal Impedance Parameters

25 W — 90 MHz

**RF POWER
TRANSISTOR**

NPN SILICON

2



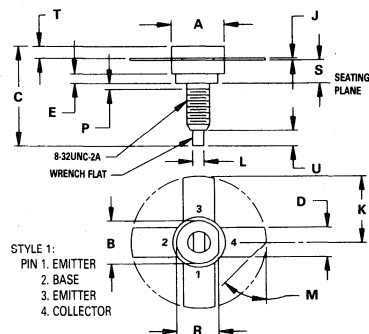
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	70 400	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Stud Torque (2)	—	6.5	In. Lb.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF Amplifier.
(2) For repeated assembly use 5 In. Lb.



STYLE 1:
PIN 1, EMITTER
2, BASE
3, EMITTER
4, COLLECTOR

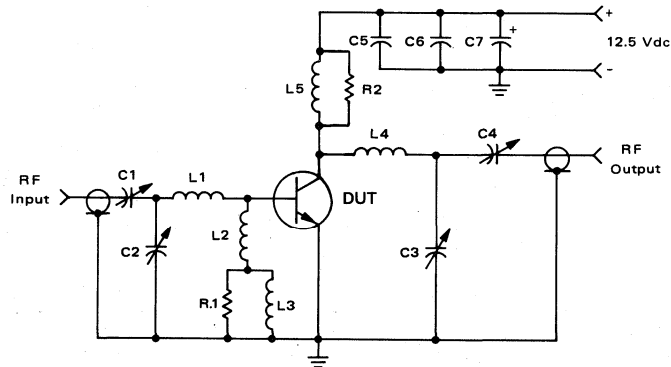
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	100	120	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 25\text{ W}$, $f = 90\text{ MHz}$)	G_{pE}	9.5	—	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 25\text{ W}$, $f = 90\text{ MHz}$)	η	55	—	—	%
Load Mismatch ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 25\text{ W}$, $f = 90\text{ MHz}$, $T_C \leq 25^\circ\text{C}$)	—	No Degradation in Output Power			

FIGURE 1 – 90 MHz TEST CIRCUIT SCHEMATIC

C1,C4 5.0-80 pF, ARCO 462

C2,C3 25-280 pF, ARCO 464

C5 1000 pF UNELCO

C6 0.047 μF , ERIE disc ceramicC7 10 μF , 15 Vdc TANTALUM

L1 1 Turn, #16 AWG, 3/8" I.D., 1/8" Long

L2 0.22 μH , 9230-04 MILLER Molded ChokeL3 22 μH , 9230-52 MILLER Molded Choke

L4 2 Turns, #14 AWG, 3/8" I.D., 1/4" Long

L5 10 Turns, #18 AWG, 1/4" I.D., wound on R2

R1 15 Ohms, 1/2 W, 10%

R2 47 Ohm, 1 W Carbon

Input/Output Connector – Type BNC

FIGURE 2 – OUTPUT POWER versus INPUT POWER

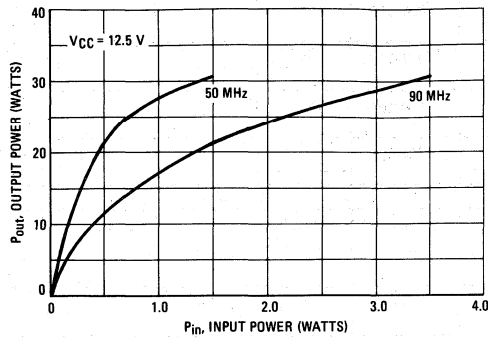


FIGURE 3 – OUTPUT POWER versus FREQUENCY

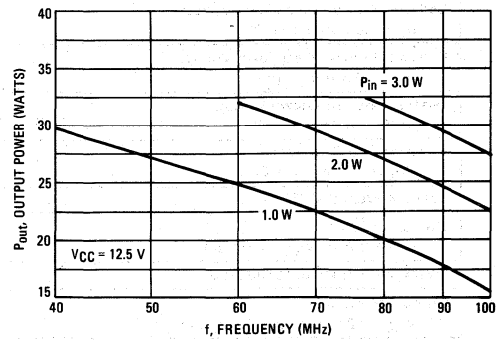


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

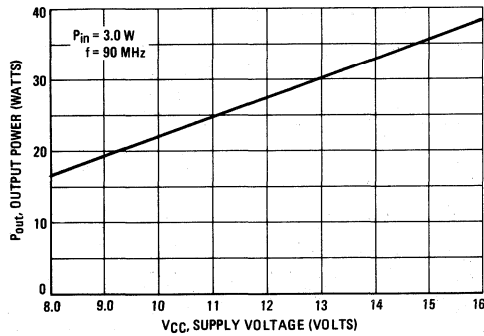
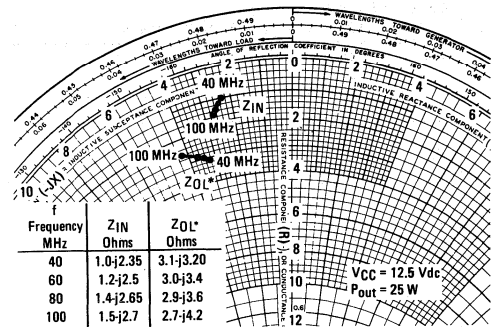
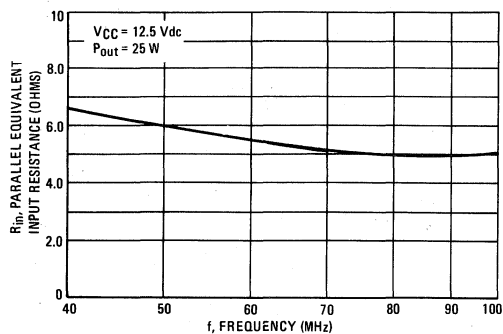
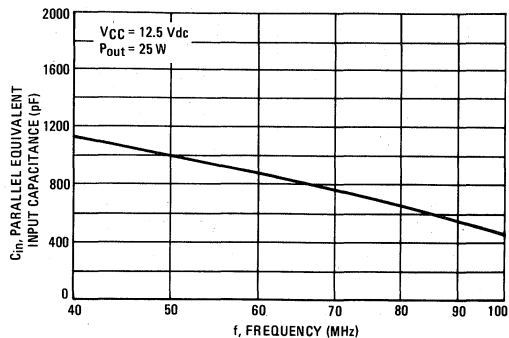
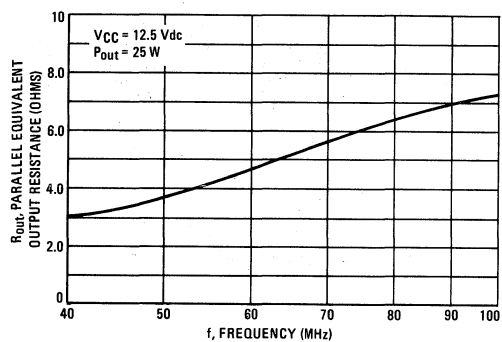
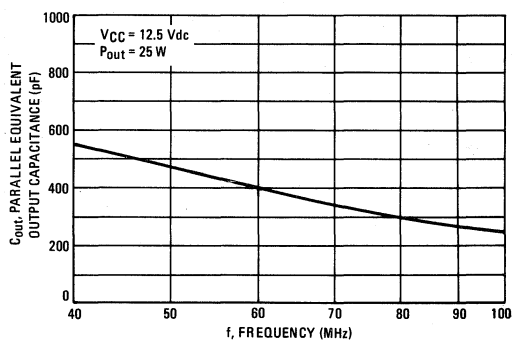


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



* Z_{out} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 – PARALLEL EQUIVALENT INPUT RESISTANCE
versus FREQUENCYFIGURE 7 – PARALLEL EQUIVALENT INPUT CAPACITANCE
versus FREQUENCYFIGURE 8 – PARALLEL EQUIVALENT OUTPUT RESISTANCE
versus FREQUENCYFIGURE 9 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE
versus FREQUENCY

MRF237

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt large-signal power amplifier applications in communication equipment operating to 225 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
Output Power = 4.0 Watts
Minimum Gain = 12 dB
Efficiency = 50%
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Grounded Emitter TO-39 Package for High Gain and Excellent Heat Dissipation
- Replaces Medium Power Stud Mount Devices

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	8.0 45.7	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	22	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.25	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 250 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	5.0	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$, $f = 0.1 \text{ MHz}$)	C_{ob}	—	15	20	pF
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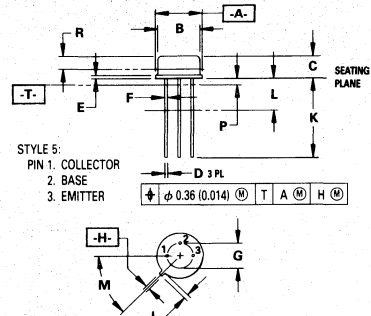
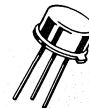
FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($P_{out} = 4.0 \text{ W}$, $V_{CC} = 12.5 \text{ Vdc}$, $f = 175 \text{ MHz}$)	G_{PE}	12	14	—	dB
Collector Efficiency ($P_{out} = 4.0 \text{ W}$, $V_{CC} = 12.5 \text{ Vdc}$, $f = 175 \text{ MHz}$)	η	50	62	—	%

4 W — 175 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 5:

- PIN 1. COLLECTOR
2. BASE
3. EMITTER

NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.
- DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
- DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
- DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-05
TO-206AF
(TO-39)**

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC

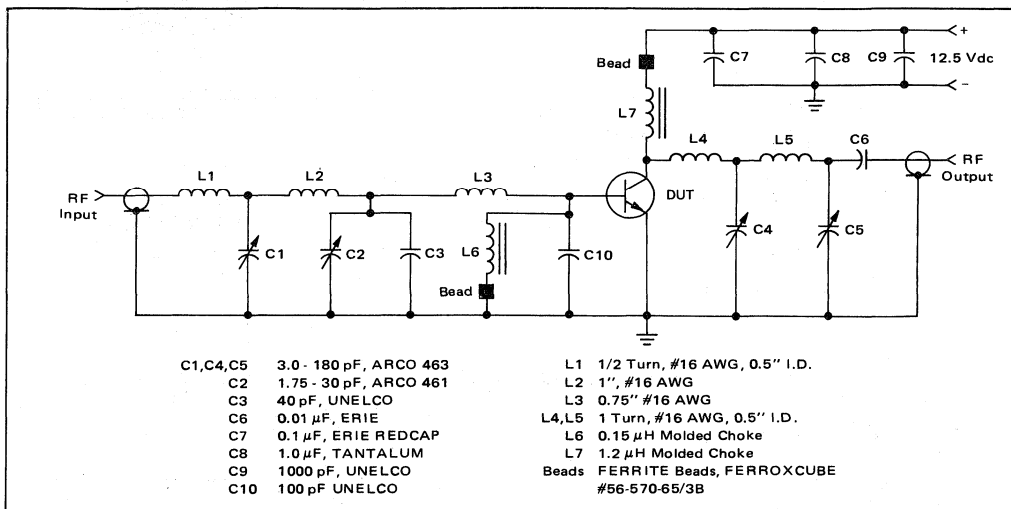


FIGURE 2 — OUTPUT POWER versus INPUT POWER

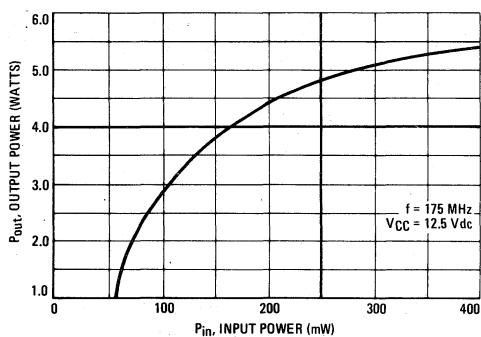


FIGURE 3 — OUTPUT POWER versus FREQUENCY

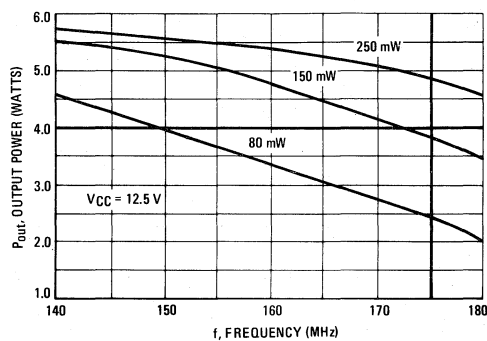


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

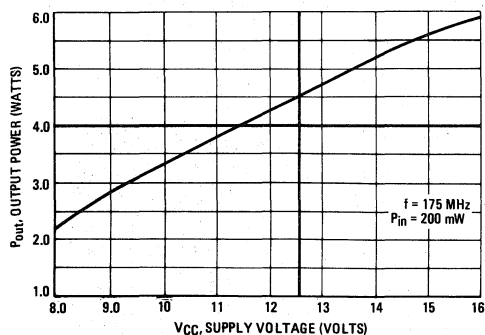
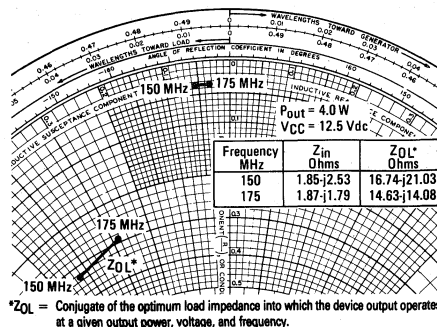


FIGURE 5 — SERIES EQUIVALENT IMPEDANCE



MRF240
MRF240A

The RF Line

NPN SILICON RF POWER TRANSISTORS

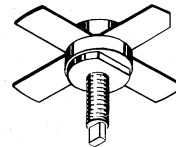
... designed for 13.6 volt VHF large-signal class C and class AB linear power amplifier applications in commercial and industrial equipment.

- High Common Emitter Power Gain
- Specified 13.6 V, 160 MHz Performance:
Output Power = 40 Watts
Power Gain = 9.0 dB Min
Efficiency = 55% Min
- Load Mismatch Capability at Rated Voltage and RF Drive
- Silicon Nitride Passivated
- Low Intermodulation Distortion, $d_3 = -30$ dB Typ

40 W — 145–175 MHz

**RF POWER
TRANSISTORS**

NPN SILICON



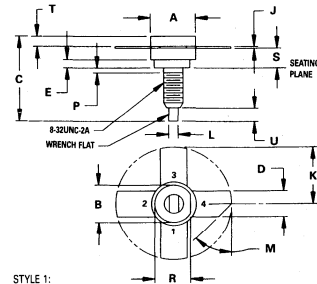
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	8.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	100 0.57	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.75	$^\circ\text{C/W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

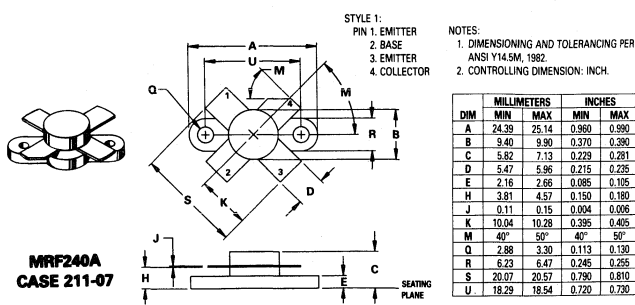


STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.590	—
L	1.40	1.78	0.055	0.070
M	45° NOM	45° NOM	—	—
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09
MRF240



ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 4.0 \text{ A}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	10	70	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 12.5 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	90	125	pF
---	----------	---	----	-----	----

FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CC} = 13.6 \text{ Vdc}$, $P_{out} = 40 \text{ W}$, $f = 160 \text{ MHz}$)	G_{PE}	9.0	10	—	dB
Collector Efficiency ($V_{CC} = 13.6 \text{ Vdc}$, $P_{out} = 40 \text{ W}$, $f = 160 \text{ MHz}$)	η	55	—	—	%

TYPICAL SSB PERFORMANCE

Intermodulation Distortion (1) ($V_{CC} = 13.6 \text{ Vdc}$, $P_{out} = 35 \text{ W (PEP)}$, $f_1 = 146 \text{ MHz}$, $f_2 = 146.002 \text{ MHz}$, $I_{CQ} = 50 \text{ mA}$)	IMD (dB)	—	-30	—	dB
---	----------	---	-----	---	----

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 160 MHz TEST CIRCUIT SCHEMATIC

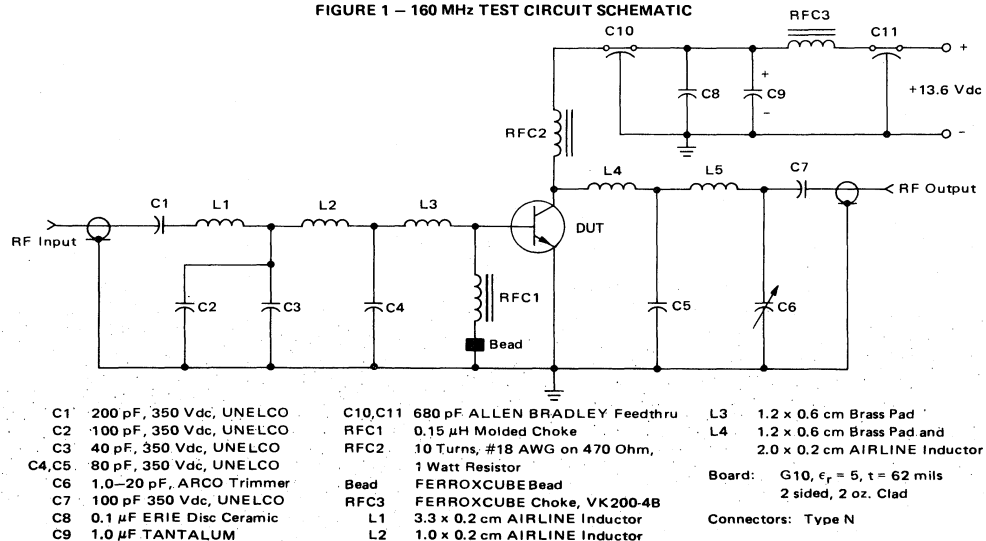


FIGURE 2 — POWER GAIN versus FREQUENCY

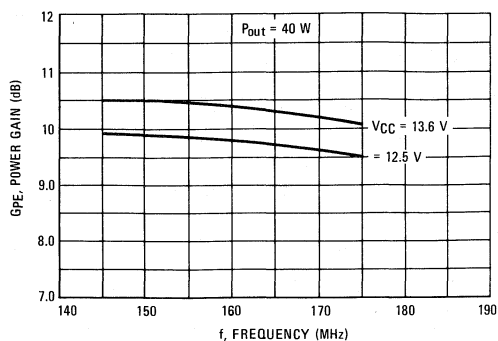


FIGURE 3 — OUTPUT POWER versus INPUT POWER

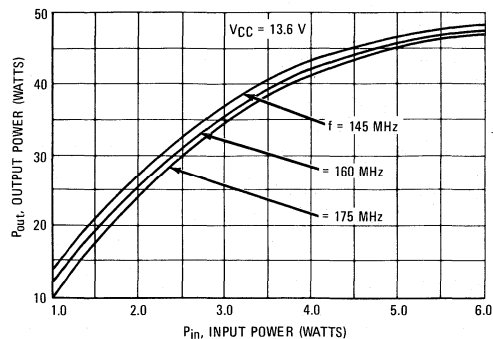


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
145 MHz

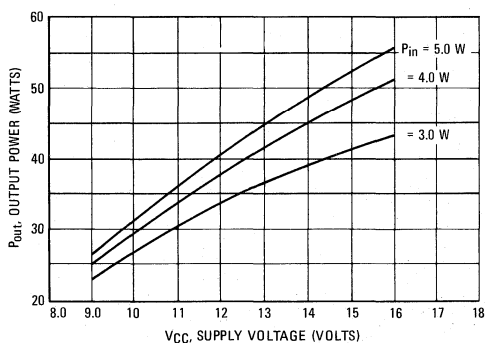


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
160 MHz

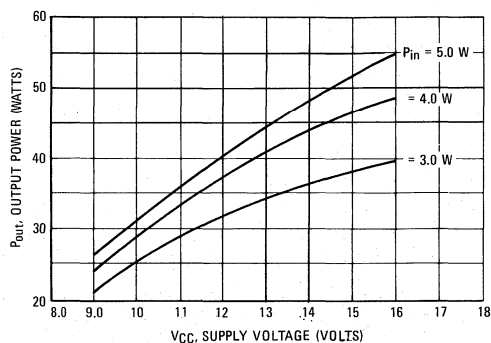


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

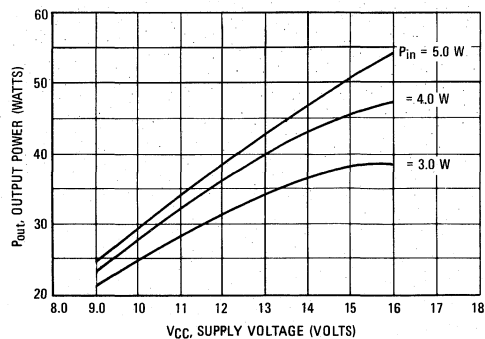
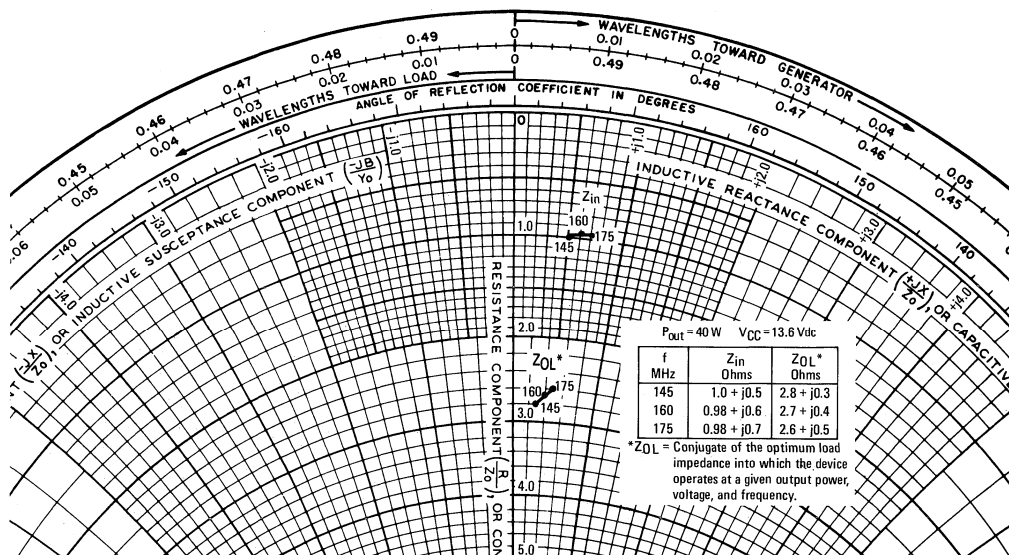


FIGURE 7 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



MRF247

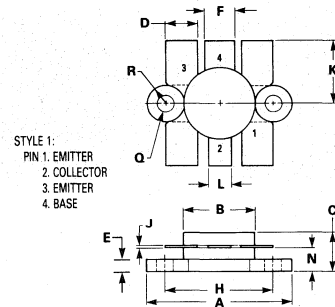
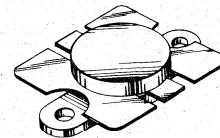
The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt VHF large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
 Output Power = 75 Watts
 Minimum Gain = 7.0 dB
 Efficiency = 55%
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Internal Matching Network Optimized for Minimum Gain Frequency Slope Response Over the Range 136 to 175 MHz
- Load Mismatch Capability at Rated P_{out} and Supply Voltage

75 W — 175 MHz
CONTROLLED Q
RF POWER
TRANSISTOR
NPN SILICON



STYLE 1:
 PIN 1. EMITTER
 2. COLLECTOR
 3. EMITTER
 4. BASE

NOTE:
 FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Peak	I_C	20	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1)	P_D	250	Watts
Derate Above 25°C		1.43	W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R\theta_{JC}$	0.7	$^\circ\text{C/W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS ($T_C = 25^{\circ}\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	75	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	235	300	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 75\text{ Watts}$, $f = 175\text{ MHz}$)	G_{PE}	7.0	8.5	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 75\text{ Watts}$, $f = 175\text{ MHz}$)	η	55	60	—	%
Load Mismatch ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 75\text{ Watts}$, $f = 175\text{ MHz}$, $VSWR = 30:1$ All Phase Angles)	ψ	No Degradation In Output Power			

FIGURE 1 — OUTPUT POWER versus INPUT POWER

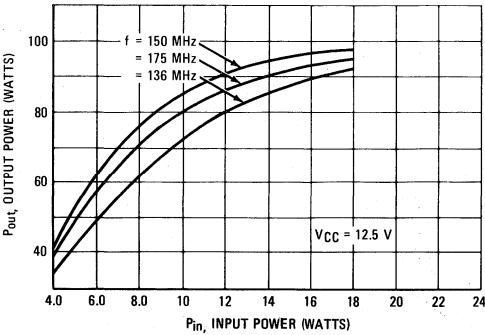


FIGURE 2 — POWER GAIN versus FREQUENCY

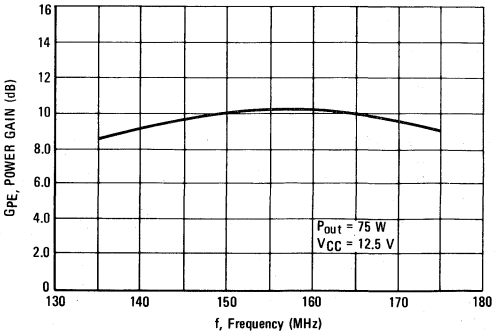


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE
136 MHz

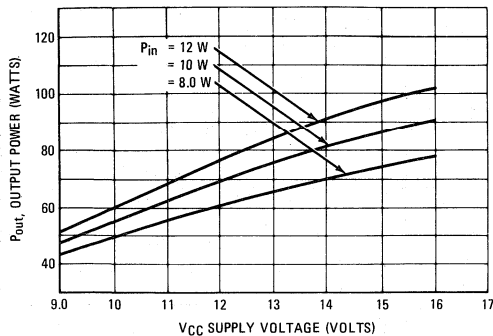


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
150 MHz

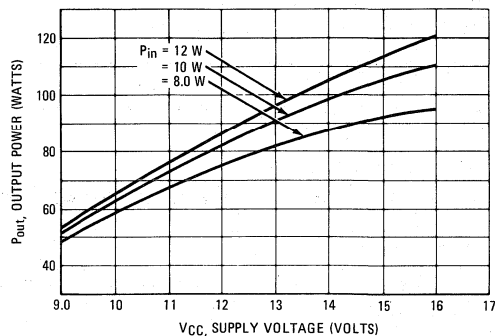


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

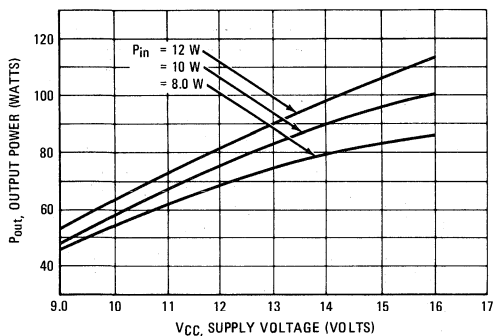
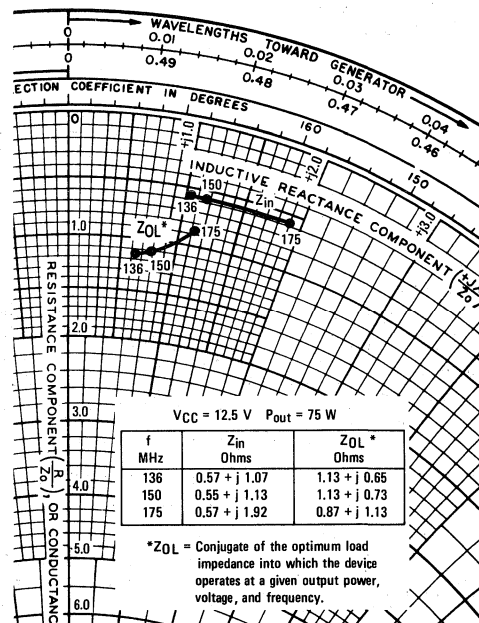


FIGURE 6 — SERIES EQUIVALENT IMPEDANCES



MRF260

The RF Line

NPN SILICON RF POWER TRANSISTOR

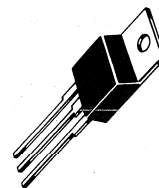
... designed for 12.5 Volt VHF large-signal power amplifier applications in commercial and industrial equipment.

- Low-Cost Common-Emitter TO-220AB Package
- Specified 12.5 V, 175 MHz Performance:
 - Output Power 5.0 Watts
 - Power Gain 10 dB Min
 - Efficiency 55% Min
- Load Mismatch Capability at High Line and Rated RF Input
- Other Devices in the Series:
 - MRF261 10 Watts
 - MRF262 15 Watts
 - MRF264 30 Watts

5 W 136–175 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



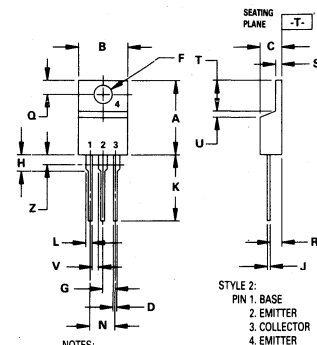
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	12 68.5	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	14.6	$^\circ\text{C/W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
- (2) Thermal Resistance is determined under specified RF operating conditions by infra-red measurement techniques.



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

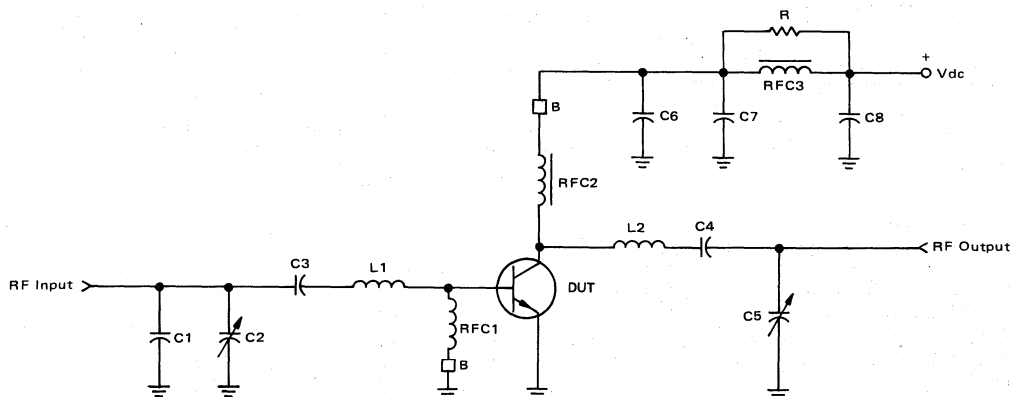
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.62	0.160	0.190
D	0.64	0.98	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.83	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

**CASE 221A-04
TO-220AB**

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	15	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 5.0 \text{ W}$, $f = 175 \text{ MHz}$)	G_{PE}	10	11	—	dB
Collector Efficiency ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 5.0 \text{ W}$, $f = 175 \text{ MHz}$)	η	55	—	—	%

FIGURE 1 — 175 MHz TEST CIRCUIT



C1 — 40 pF Underwood
 C2, C5 — Johanson Trimmer #JMC-5501
 C3 — 60 pF Underwood
 C4 — 25 pF Underwood
 C6 — 1000 pF Underwood
 C7 — 0.1 μF Erie Red Cap
 C8 — 100 μF Electrolytic, 15 V

L1 — 1-1/2 Turns, #18 AWG, 3/16" ID, $l = 1/8"$
 L2 — 3 Turns, #18 AWG, 5/16" ID, $l = 1/4"$
 R — 10 Ω , 1.0 W
 B — Ferroxcube Bead 56-590-65-3B
 RFC1 — 0.15 μH Molded Coil
 RFC2 — 0.15 μH Molded Coil
 RFC3 — Ferroxcube VK200-20-4B

Board Material:

Teflon Fiberglass — G10, thickness = 0.062 inches.

FIGURE 2 – POWER GAIN versus FREQUENCY

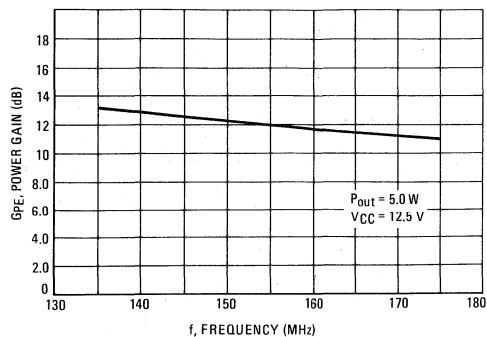


FIGURE 3 – OUTPUT POWER versus INPUT POWER

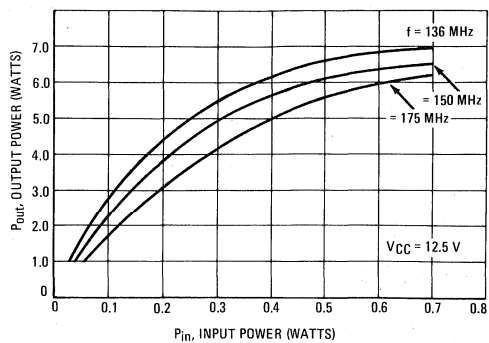
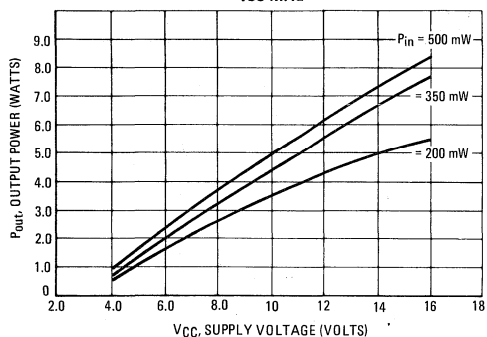
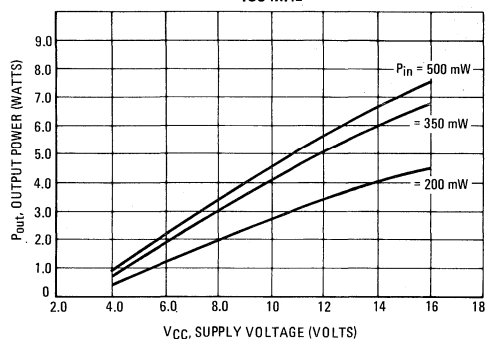
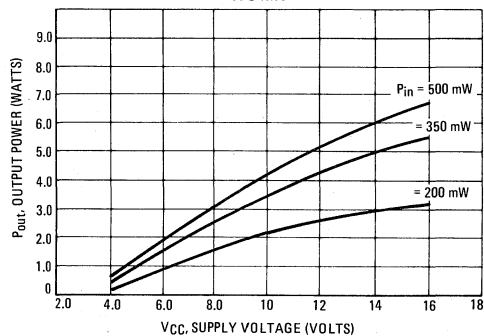
FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE
136 MHzFIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE
150 MHzFIGURE 6 – OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

FIGURE 7 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

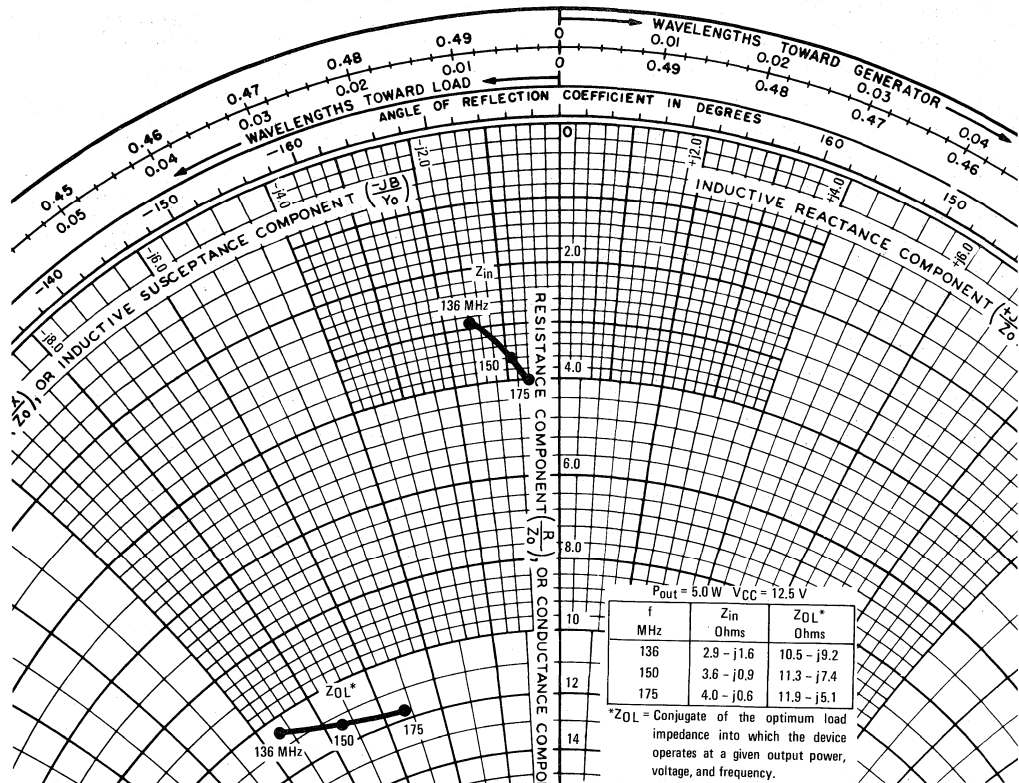
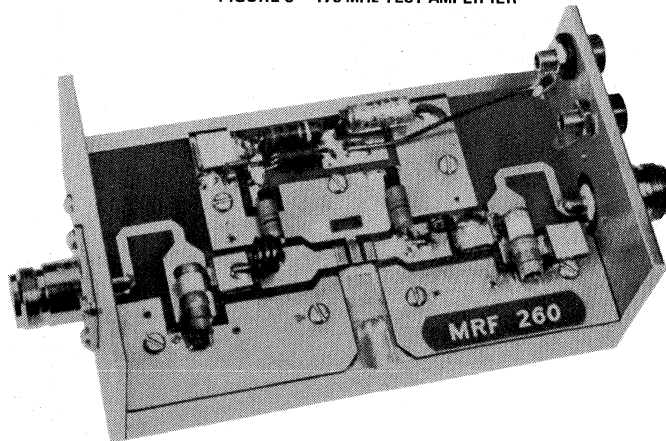


FIGURE 8 — 175 MHz TEST AMPLIFIER



MRF261

The RF Line

NPN SILICON RF-POWER TRANSISTOR

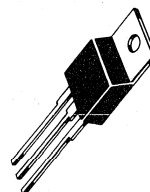
... designed for 12.5 Volt VHF large-signal power amplifier applications in commercial and industrial equipment.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 V, 175 MHz Performance —
Output Power = 10 Watts
Power Gain = 5.2 dB Min
Efficiency = 50% Min
- Load Mismatch Capability at High Line and RF Overdrive
- Other Devices in the Series —
MRF260 5.0 Watts
MRF262 15 Watts
MRF264 30 Watts

10 W 136-175 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



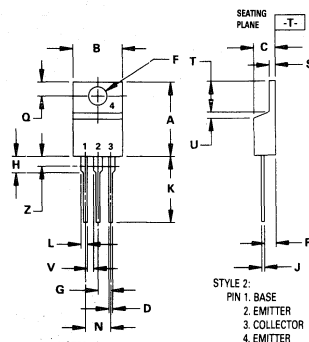
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	30 171	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.85	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



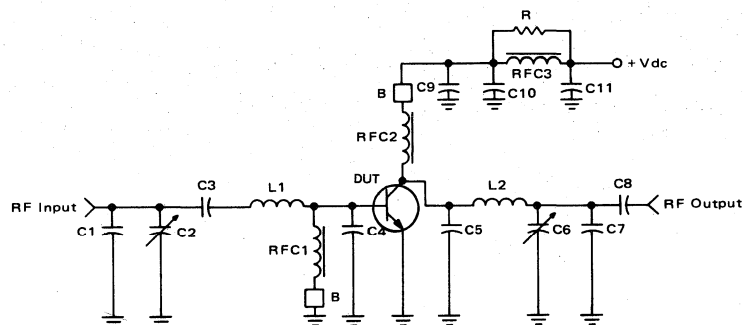
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

**CASE 221A-04
TO-220AB**

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	65	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	35	50	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 10\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	5.2	7.0	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 10\text{ W}$, $f = 175\text{ MHz}$)	η	50	—	—	%

FIGURE 1 — 175-MHz TEST CIRCUIT

C1 — 10 pF Underwood
 C2, C6 — Johanson Trimmer #5501
 C3 — 60 pF Underwood
 C4 — 150 pF Underwood
 C5 — 100 pF Underwood
 C7, C8 — 15 pF Underwood
 C9 — 1000 pF Underwood
 C10 — 0.1 μF Erie Red Cap
 C11 — 100 μF Electrolytic, 15 Vdc

L1 — 2 Turns, #18 AWG, 5/16" ID
 L2 — 1-1/2 Turns, #18 AWG, 5/16" ID
 R — 10 Ω , 1.0 W
 B — Ferroxcube Bead 56-590-65-3B
 RFC1 — 0.15 μH Molded Coil
 RFC2 — 6 Turns #18 Wire, 5/16" ID
 RFC3 — VK200-20/4B
 Board Material — Teflon Fiberglass
 t = 0.062"

FIGURE 2 — POWER GAIN versus FREQUENCY

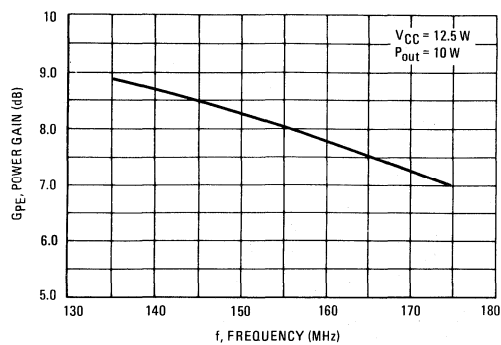


FIGURE 3 — OUTPUT POWER versus INPUT POWER

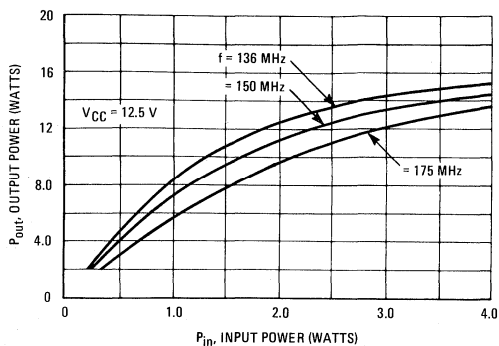
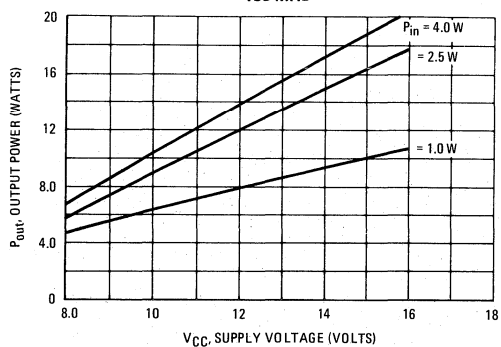
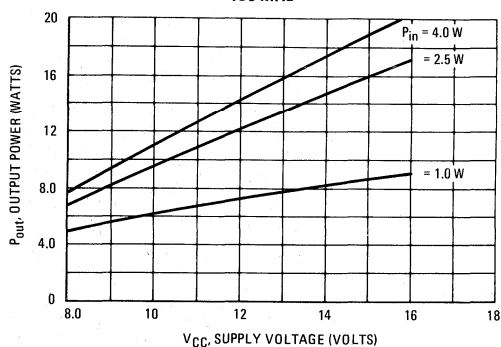
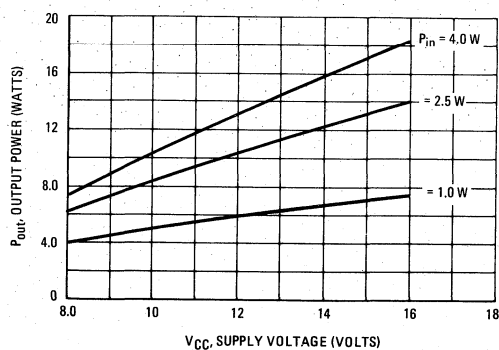
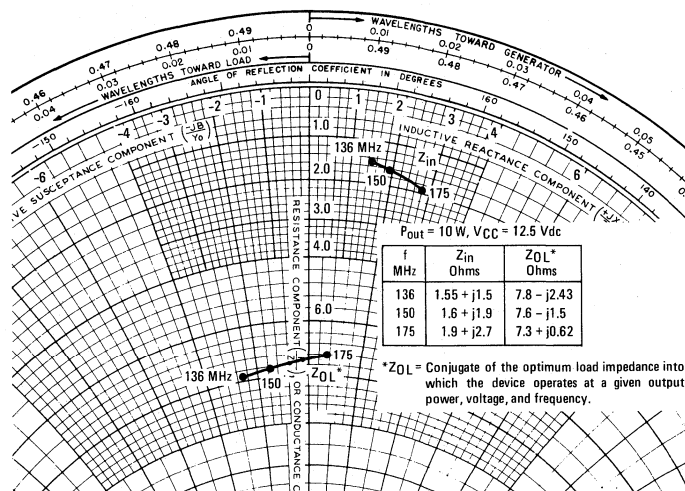
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
136 MHzFIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
150 MHzFIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

FIGURE 7 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



MRF262

The RF Line

NPN SILICON RF POWER TRANSISTOR

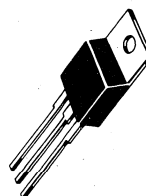
... designed for 12.5 Volt VHF large-signal power amplifier applications in commercial and industrial equipment.

- Low-Cost Common-Emitter TO-220AB Package
- Specified 12.5 V, 175 MHz Performance:
 - Output Power 15 Watts
 - Power Gain 6.3 dB Min
 - Efficiency 55% Min
- Load Mismatch Capability at Rated Voltage and RF Drive
- Other Devices in the Series:
 - MRF260 5.0 Watts
 - MRF261 10 Watts
 - MRF264 30 Watts

15 W 136 - 175 MHz

RF POWER TRANSISTOR

NPN SILICON



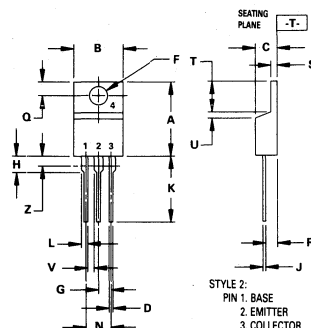
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	40 225	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	4.38	$^\circ\text{C/W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

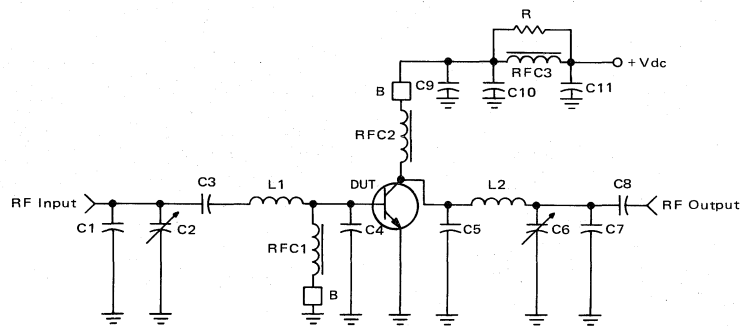
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 500\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	40	60	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	6.3	8.2	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 175\text{ MHz}$)	η	55	—	—	%

FIGURE 1 — 175 MHz TEST CIRCUIT



C1 — 10 pF Underwood
 C2, C6 — Johanson Trimmer #5501
 C3 — 60 pF Underwood
 C4 — 150 pF Underwood
 C5 — 100 pF Underwood
 C7, C8 — 15 pF Underwood
 C9 — 1000 pF Underwood
 C10 — 0.1 μF Erie Red Cap
 C11 — 100 μF Electrolytic, 15 Vdc

L1 — 2 Turns, #18 AWG, 5/16" ID
 L2 — 1-1/2 Turns, #18 AWG, 5/16" ID
 R — 10 Ω , 1.0 W
 B — Ferroxcube Bead 56-590-65-3B
 RFC1 — 0.15 μH Molded Coil
 RFC2 — 6 Turns #18 Wire, 5/16" ID
 RFC3 — VK200-20/4B
 Board Material — Teflon Fiberglass
 t = 0.062"

FIGURE 2 – POWER GAIN versus FREQUENCY

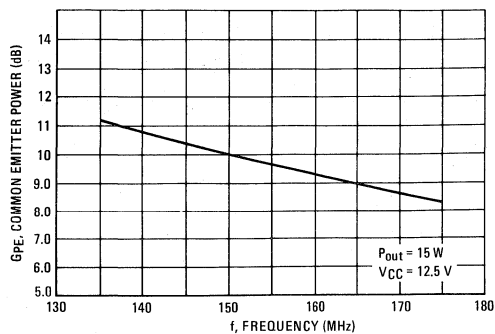


FIGURE 3 – OUTPUT POWER versus INPUT POWER

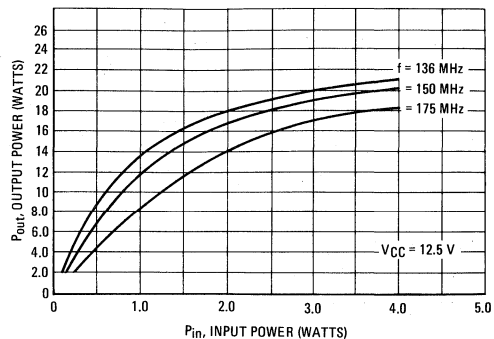
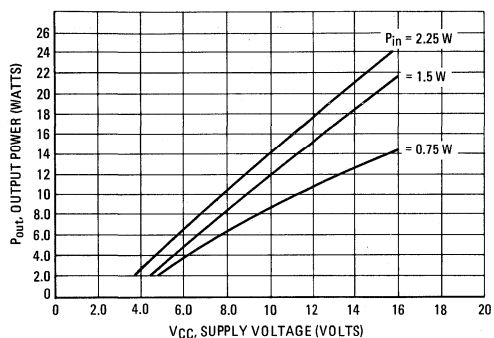
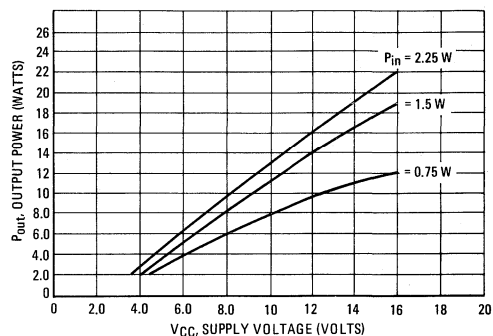
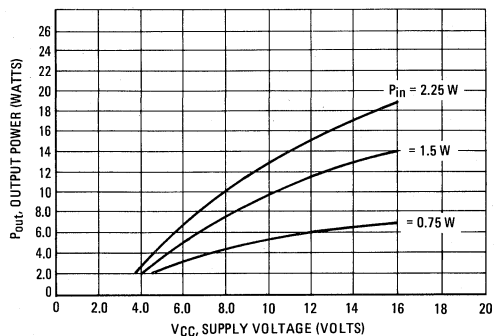
FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE
136 MHzFIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE
150 MHzFIGURE 6 – OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

FIGURE 7 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

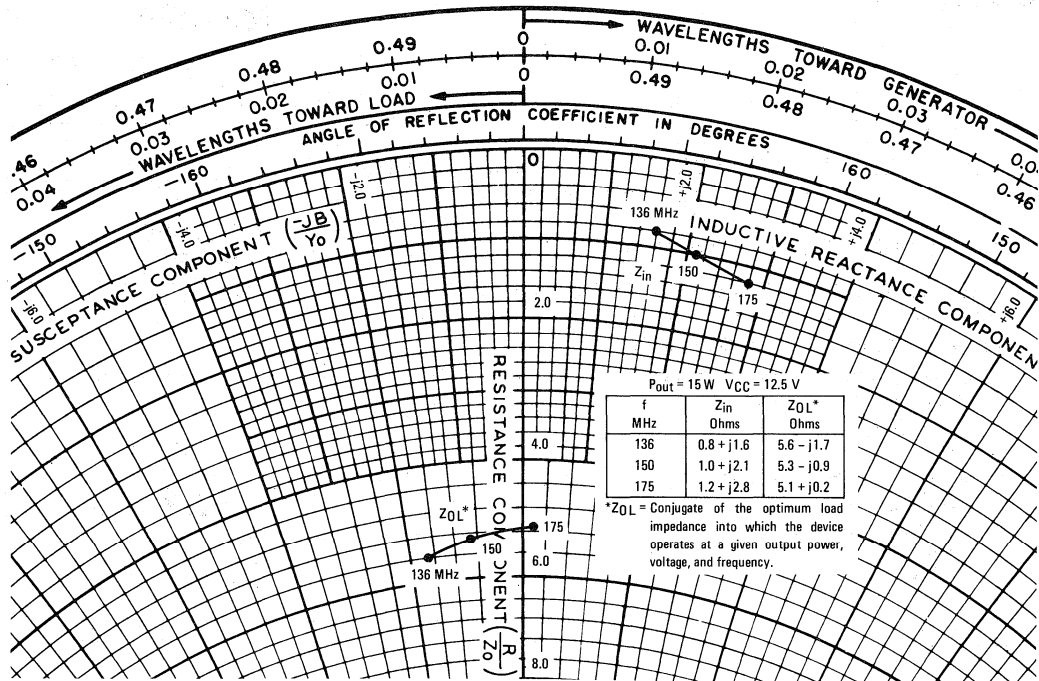
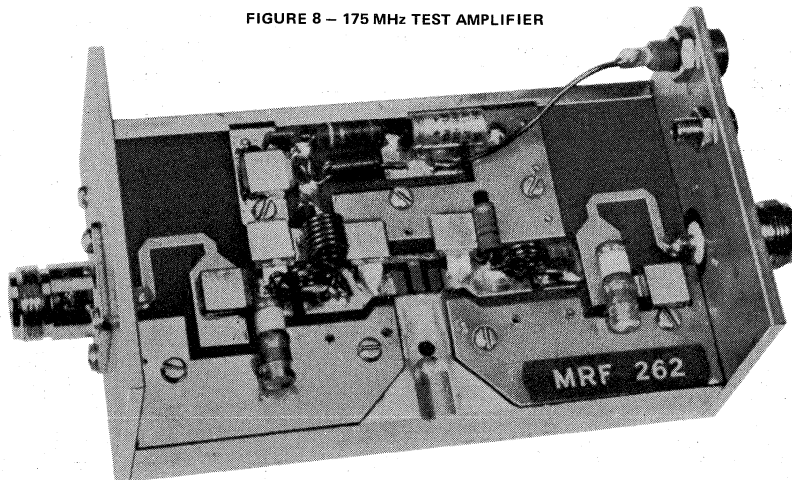


FIGURE 8 — 175 MHz TEST AMPLIFIER



The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5-volt VHF large-signal power amplifier applications in commercial and industrial FM equipment.

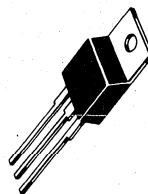
- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 V, 175 MHz Performance —
Output Power = 30 Watts
Power Gain = 5.2 dB Min
Efficiency = 60% Min
- Load Mismatch Capability at High Line and RF Overdrive
- Other Devices in the Series —
MRF260 5.0 Watts
MRF261 10 Watts
MRF262 15 Watts

MRF264

30 W 136–175 MHz

RF POWER TRANSISTOR

NPN SILICON



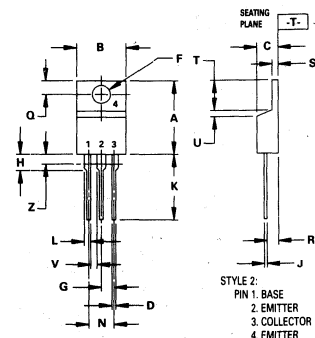
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	16	Vdc
Collector-Base Voltage	V_{CB0}	36	Vdc
Emitter-Base Voltage	V_{EB0}	4.0	Vdc
Collector-Current — Continuous	I_C	6.0	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	80 0.64	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.56	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.33	0.110	0.155
J	0.36	0.56	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CES}	—	—	5.0	mA

ON CHARACTERISTICS

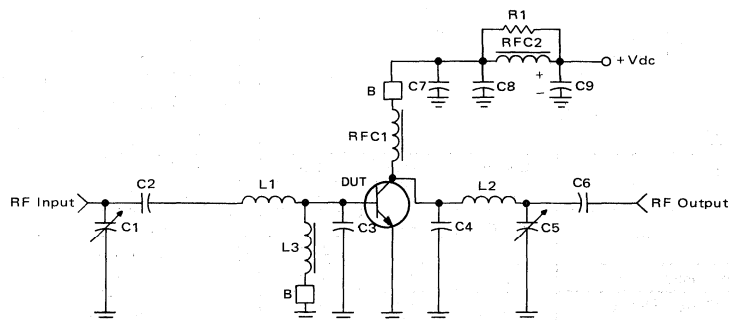
DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	50	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	70	85	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 175\text{ MHz}$)	G_{pE}	5.2	6.0	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 175\text{ MHz}$)	η	60	—	—	%

FIGURE 1 – 175 MHz TEST CIRCUIT

C1, C5 – 1.0–20 pF Johanson
 C2 – 25 pF Unelco
 C3 – 120 pF Unelco
 C4 – 100 pF Unelco
 C6 – 15 pF Unelco
 C7 – 1000 pF Unelco
 C8 – 0.1 pF Erie Redcap
 C9 – 100 μF , Electrolytic, 15 Vdc

L1 – 2-1/2 Turns, #16 AWG 0.35" ID
 L2 – 2 Turns, #16 AWG 0.25" ID
 L3 – 0.15 μH Molded Choke
 RFC1 – 5 Turns, #18 AWG 0.25" ID
 RFC2 – Ferroxcube VK200 21/4B
 R1 – 10 Ω , 2.0 W
 B – Ferroxcube Bead 56-590-65-3B

FIGURE 2 — POWER GAIN versus FREQUENCY

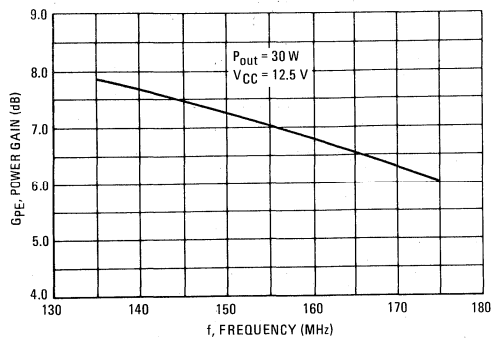


FIGURE 3 — OUTPUT POWER versus INPUT POWER

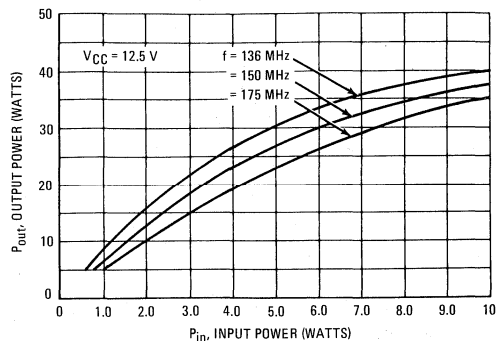
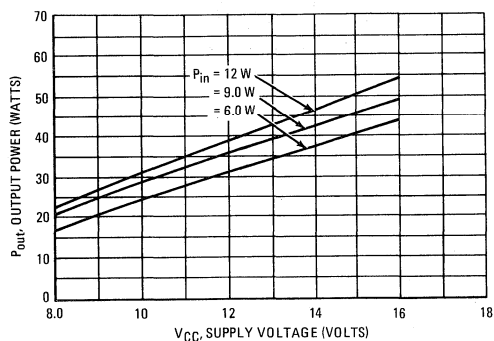
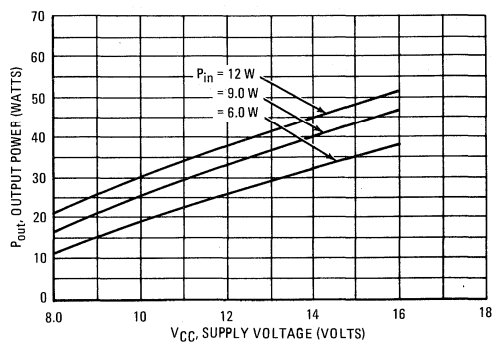
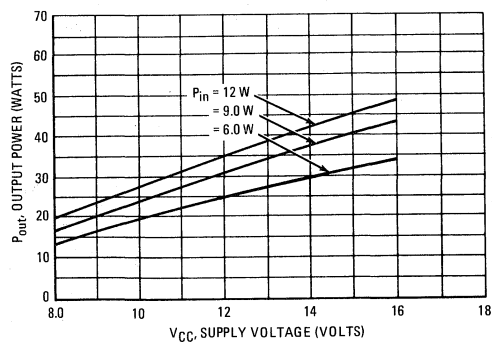
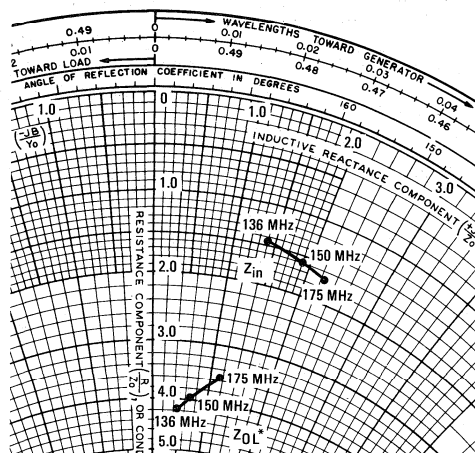
FIGURE 4 — OUTPUT POWER SUPPLY VOLTAGE
136 MHzFIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
150 MHzFIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

FIGURE 7 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



$P_{out} = 30 \text{ W}$, $V_{CC} = 12.5 \text{ V}$

f MHz	Z _{in} Ohms	Z _{0L} * Ohms
136	1.44 + j1.4	4.16 + j0.48
150	1.55 + j1.92	3.96 + j0.65
175	1.67 + j2.22	3.59 + j1.17

*Z_{0L} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

MRF309

The RF Line

NPN SILICON RF POWER TRANSISTOR

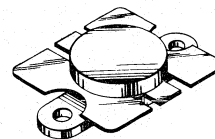
...designed primarily for wideband large-signal output amplifier stages in the 420-450 MHz frequency range.

- Guaranteed Performance in 450 MHz Amplifier @ 28 Vdc
Output Power = 50 Watts
Minimum Gain = 7.0 dB @ 450 MHz
- Built-In Matching Network for Broadband Operation Using Double Match Technique
- 100% Tested for Load Mismatch at all Phase Angles with 20:1 VSWR

50 W-450 MHz

**CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	146 0.83	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.2	$^\circ\text{C/W}$

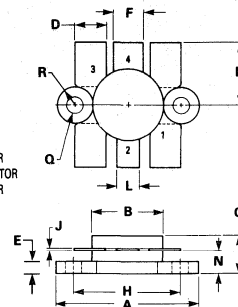
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

MATCHING PROCEDURE

In the push-pull circuit configuration it is preferred that the transistors are used as matched pairs to obtain optimum performance.

The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE



NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

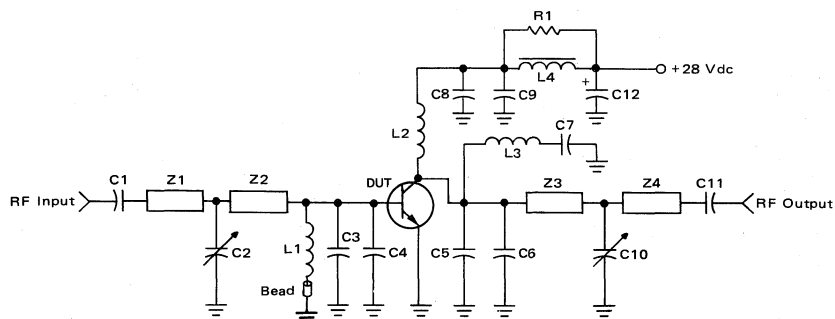
ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 450\text{ MHz}$)	G_{pE}	7.0	8.0	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 450\text{ MHz}$)	η	50	—	—	%
Electrical Ruggedness ($P_{out} = 50\text{ W}$, $V_{CC} = 28\text{ Vdc}$, $f = 450\text{ MHz}$, VSWR 20:1 all phase angles)	—	No Degradation in P_{out}			
Series Equivalent Input/Output Impedance ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 450\text{ MHz}$)	Z_{in}	$0.7 + j1.6$		$Z_{OL}^* 1.9 + j0.9$	

NOTE: For linear operation, apply forward bias such that I_{CQ} (no RF signal) is 5.0–50 mA.

* Z_{OL} = Conjugate of the load impedance into which the device output operates at a given output power, supply voltage and frequency.

FIGURE 1 – 450 MHz TEST AMPLIFIER



C3, C4, C5 — Underwood 25 pF
 C2, C10 — Johanson #JMC 5501 1–20 pF
 C6 — Underwood 15 pF
 C7, C8 — 0.1 μF Erie Red Cap, 100 V
 C9 — Underwood 80 pF
 C1, C11 — Underwood 40 pF
 C12 — 1.0 μF Tantalum

Z1 — Microstrip 0.200" W X 0.900" L
 Z2 — Microstrip 0.200" W X 0.200" L
 Z3 — Microstrip 0.200" W X 0.500" L
 Z4 — Microstrip 0.200" W X 0.650" L
 L1, L3 — RFC, 0.15 μH Molded Coil
 L2 — RFC, 4 Turns #20 Wire, 3/8" ID, 1/2" long
 L4 — RFC, Ferroxcube VK200 19/4B

R1 — 5.6 Ω

Bead — Ferroxcube 56-590-65/4B

Board Material — 0.062" Thick glass — Teflon, $\epsilon_r = 2.56$

MRF313

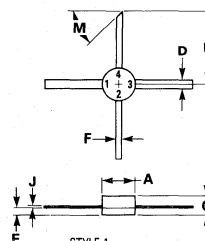
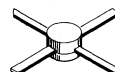
The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed for wide band amplifier, driver or oscillator applications in military, mobile, and aircraft radio.

- Specified 28 Volt, 400 MHz Characteristics —
Output Power = 1.0 Watt
Minimum Gain = 15 dB
Efficiency = 45%.
- Emitter Ballast and Low Current Density for Improved MTBF
- Common Emitter for Improved Stability

1.0 W — 400 MHz
HIGH FREQUENCY TRANSISTOR
NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.59	0.200	0.220
C	2.41	3.30	0.095	0.130
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	

CASE 305A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector — Emitter Voltage	V_{CEO}	30	Vdc
Collector — Base Voltage	V_{CBO}	40	Vdc
Emitter — Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	150	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	2.5 35	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

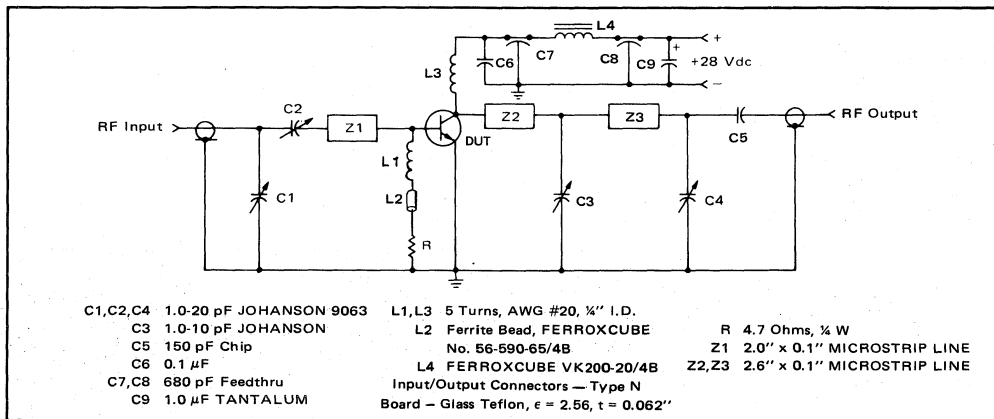
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	28.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 20\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	20	60	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 100\text{ mA}$, $V_{CE} = 20\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	—	2.5	—	GHz
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	3.5	5.0	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ⁽¹⁾ ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 400\text{ MHz}$)	G_{pe}	15	16	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 400\text{ MHz}$)	η	—	45	—	%
Series Equivalent Input Impedance ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 400\text{ MHz}$)	Z_{in}	—	$6.4-j4.8$	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 400\text{ MHz}$)	Z_{out}	—	$75-j45$	—	Ohms

(1) Class C

FIGURE 1 — 400 MHz POWER GAIN TEST CIRCUIT



MRF314
MRF314A

The RF Line

NPN SILICON RF POWER TRANSISTORS

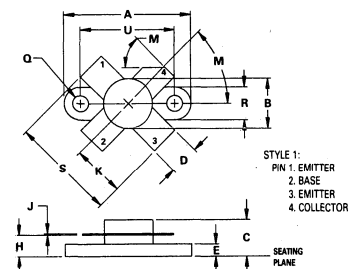
... designed primarily for wideband large-signal driver and output amplifier stages in the 30–200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
Output Power = 30 Watts
Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

30 W–30–200 MHz

**RF POWER
TRANSISTORS**

NPN SILICON



MRF314

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

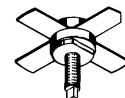
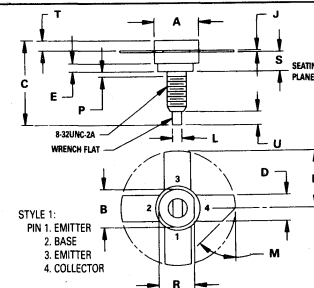
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	3.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	82 0.47	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.13	$^\circ\text{C/W}$

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.



MRF314A

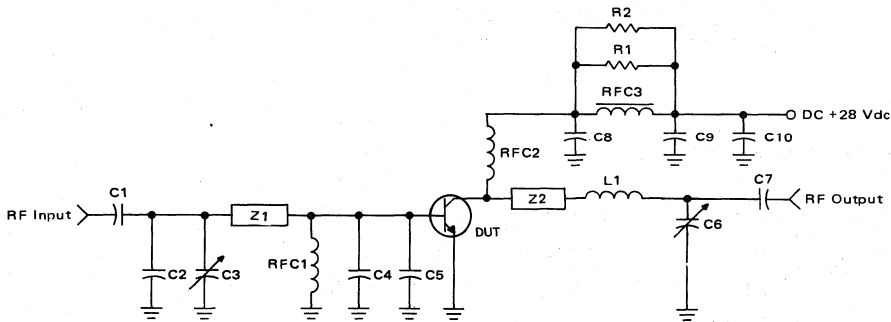
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.35	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	—	45° NOM	—	45° NOM
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

ELECTRICAL CHARACTERISTICS ($T_C = 25^{\circ}\text{C}$ unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 30\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 3.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	3.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.5\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	30	40	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 150\text{ MHz}$)	G_{pE}	10	13.5	—	db
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 150\text{ MHz}$)	η	50	—	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 150\text{ MHz}$, $VSWR = 30:1$ all phase angles)	—	No Degration in Power Output			

FIGURE 1 — 150 MHz TEST CIRCUIT



C1, C7 — 18 pF, 100 mil ATC
C2 — 68 pF, 100 mil ATC
C3, C6 — Johanson #JMC 5501
C4 — 270 pF, 100 mil ATC
C5 — 240 pF, 100 mil ATC
C8, C9 — 100 pF Underwood
C10 — 1.0 μF Tantalum
L1 — 2 Turns, 2.5" #20 Wire, ID = 0.275"

R1, R2 — 10 Ω, 1.0 W
RFC1 — 15 μH Molded Coil
RFC2 — 2 Turns, 2.5" #20 Wire, ID = 0.2"
RFC3 — Ferroxcube VK200—19/48
Z1 — Microstrip 0.168" W x 1.6" L
Z2 — Microstrip 0.168" W x 1.2" L
Board — Glass Teflon $\epsilon_r \approx 2.55$

TYPICAL PERFORMANCE CURVES

FIGURE 2 – OUTPUT POWER versus INPUT POWER

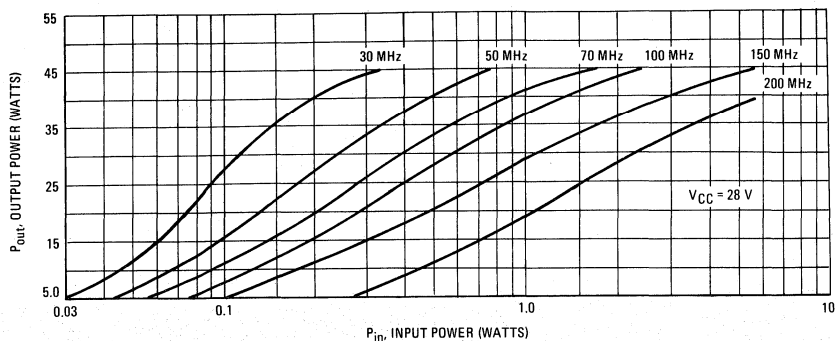


FIGURE 3 – OUTPUT POWER versus INPUT POWER

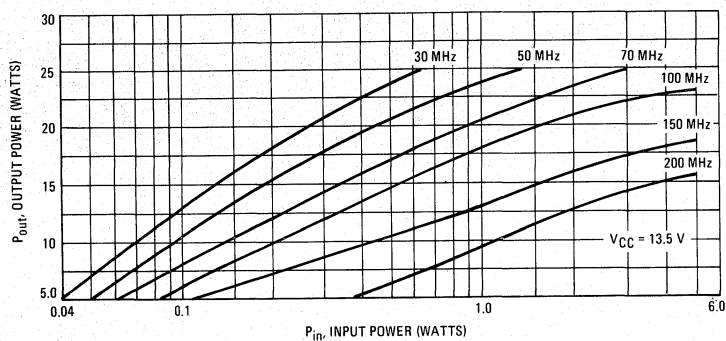


FIGURE 4 – POWER GAIN versus FREQUENCY

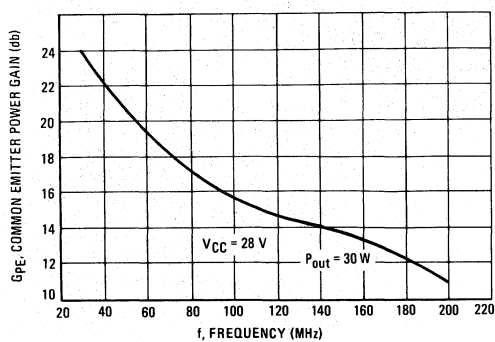
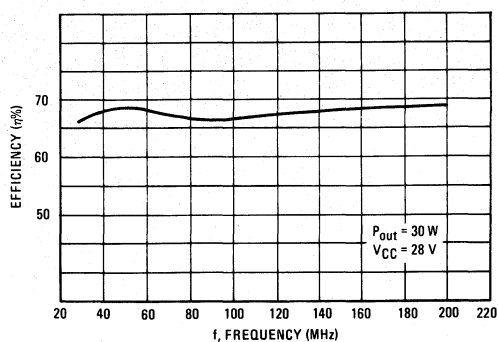
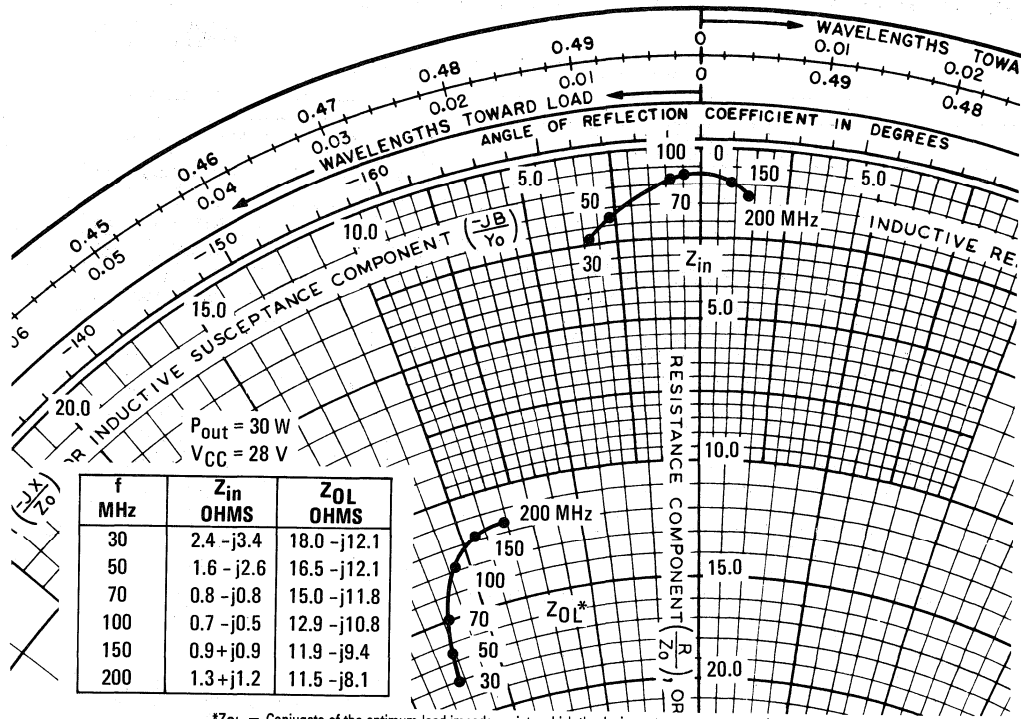
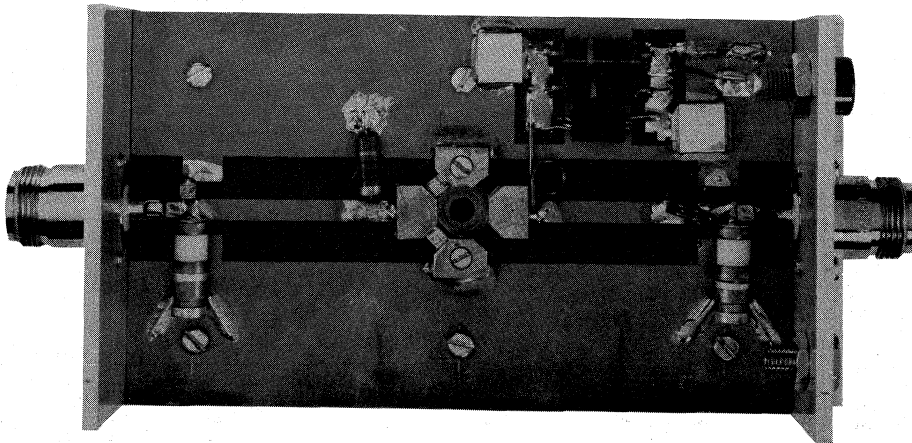
FIGURE 5 – EFFICIENCY (η %) versus FREQUENCY

FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — TEST FIXTURE



The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed primarily for wideband large-signal output amplifier stages in the 30–200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
Output Power = 45 Watts
Minimum Gain = 9.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	4.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	110 0.63	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.59	$^\circ\text{C/W}$

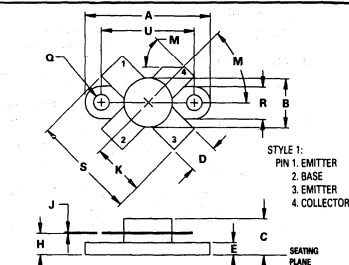
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

MRF315 MRF315A

45 W – 30–200 MHz

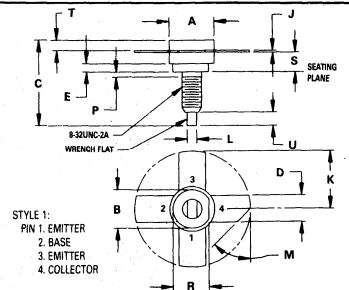
RF POWER TRANSISTORS

NPN SILICON



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07



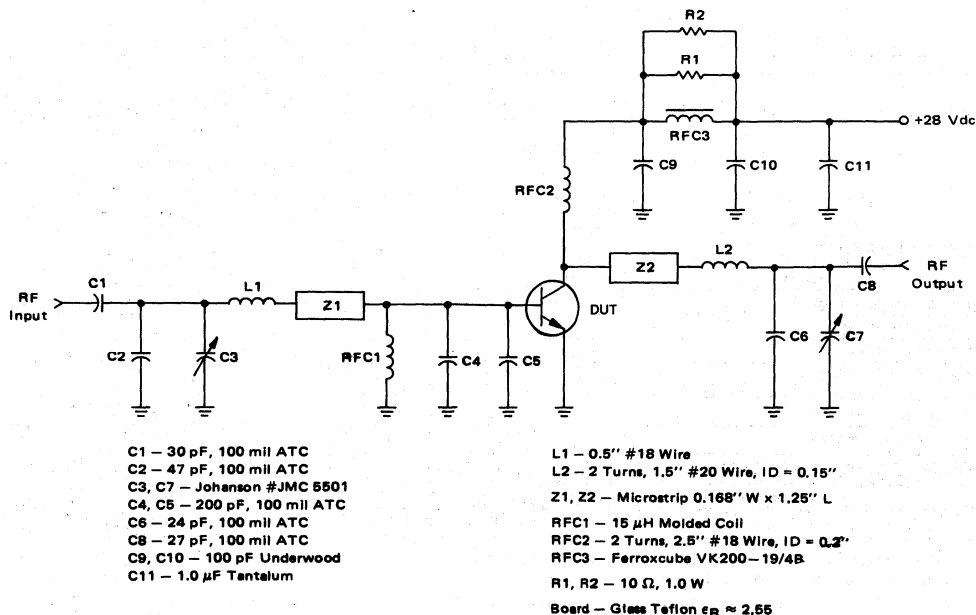
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.98	0.320	0.350
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	—	1.27	—	0.050
P	—	45° NOM	—	45° NOM
R	7.58	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 40 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 40 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 40 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 4.0 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	4.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	45	60	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28 \text{ Vdc}$, $P_{out} = 45 \text{ W}$, $f = 150 \text{ MHz}$)	G_{PE}	9.0	11	—	dB
Collector Efficiency ($V_{CC} = 28 \text{ Vdc}$, $P_{out} = 45 \text{ W}$, $f = 150 \text{ MHz}$)	η	50	—	—	%
Load Mismatch ($V_{CC} = 28 \text{ Vdc}$, $P_{out} = 45 \text{ W}$, $f = 150 \text{ MHz}$, VSWR = 30:1 all phase angles)	No Degradation in Power Output				

FIGURE 1 — 150 MHz TEST CIRCUIT



TYPICAL PERFORMANCE CURVES

FIGURE 2 — OUTPUT POWER versus INPUT POWER

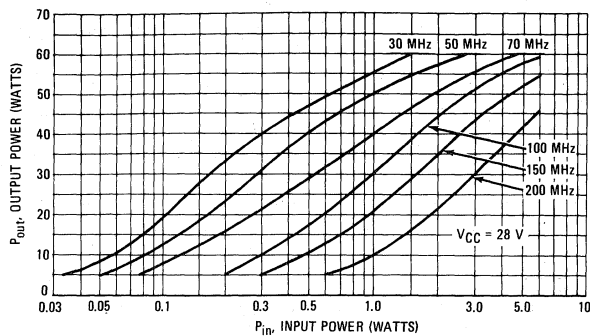


FIGURE 3 — OUTPUT POWER versus INPUT POWER

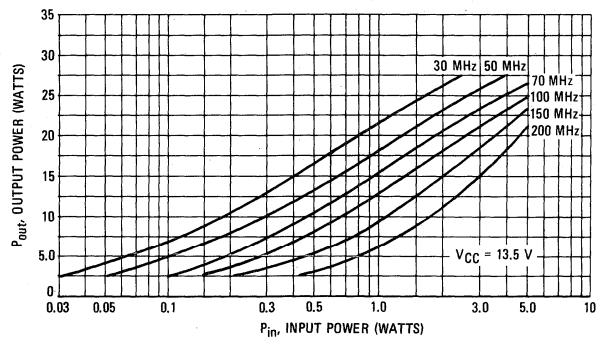


FIGURE 4 — POWER GAIN versus FREQUENCY

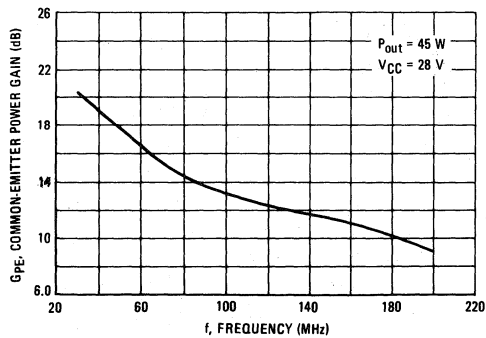


FIGURE 5 — EFFICIENCY versus FREQUENCY

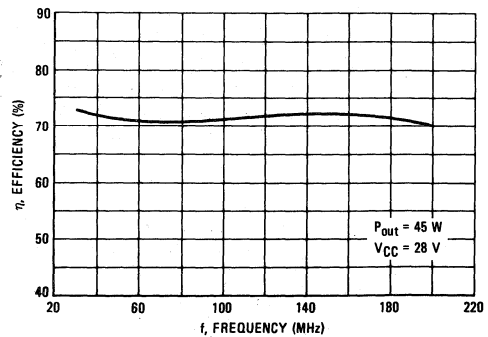
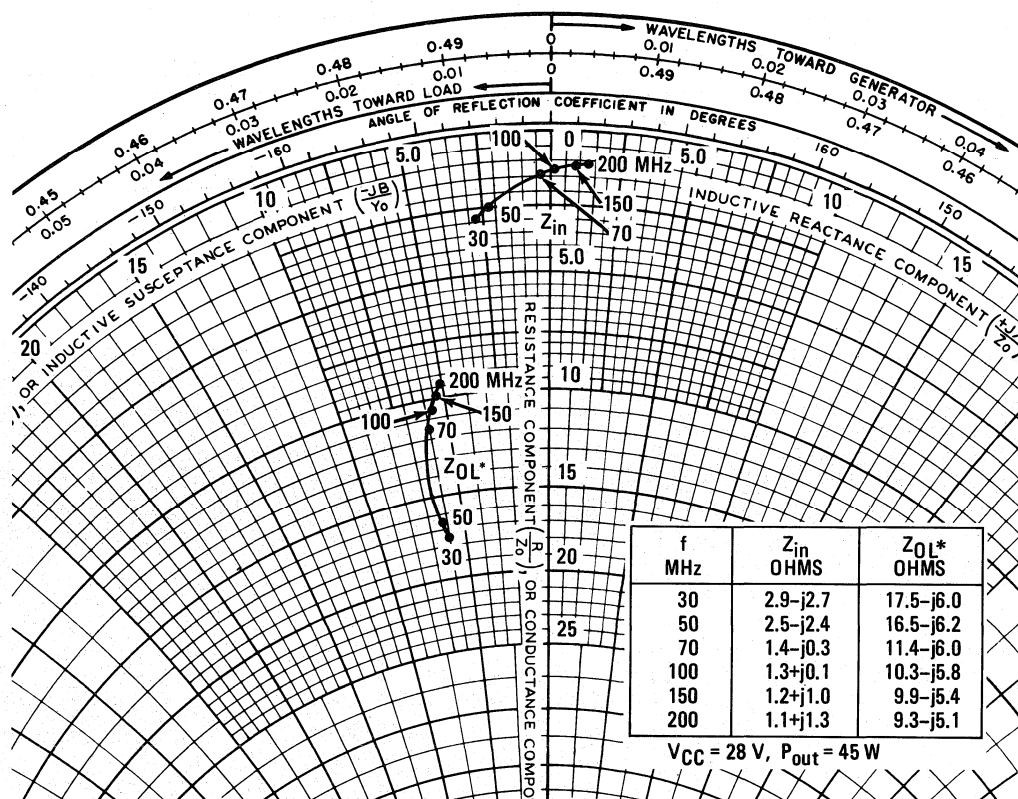
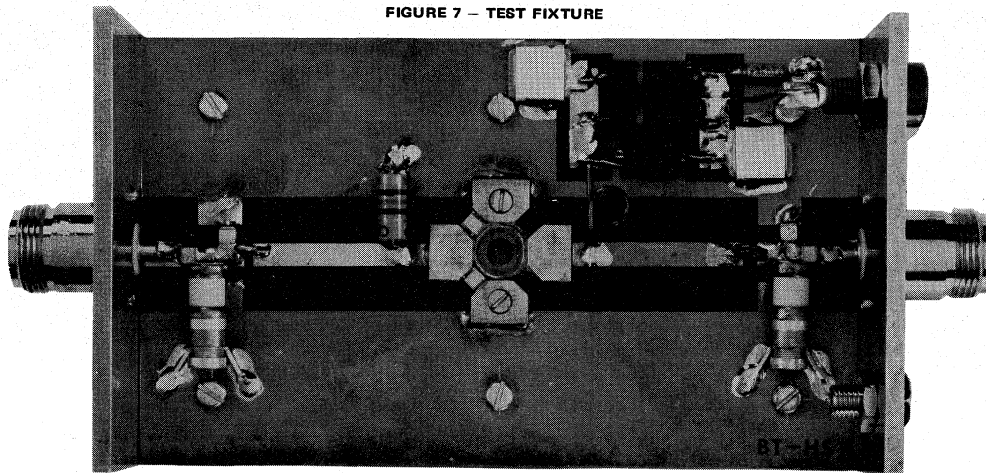


FIGURE 6 – SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 – TEST FIXTURE



MRF316

The RF Line

NPN SILICON RF POWER TRANSISTOR

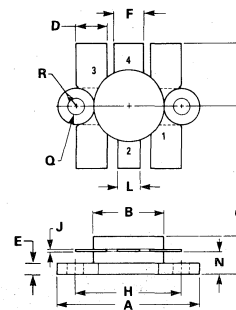
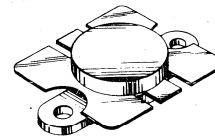
... designed primarily for wideband large-signal output amplifier stages in the 30–200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
Output Power = 80 Watts
Minimum Gain = 10 dB
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

80 W — 30–200 MHz

**CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:

- PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous Peak	I_C	9.0 13.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	220 1.26	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.8	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

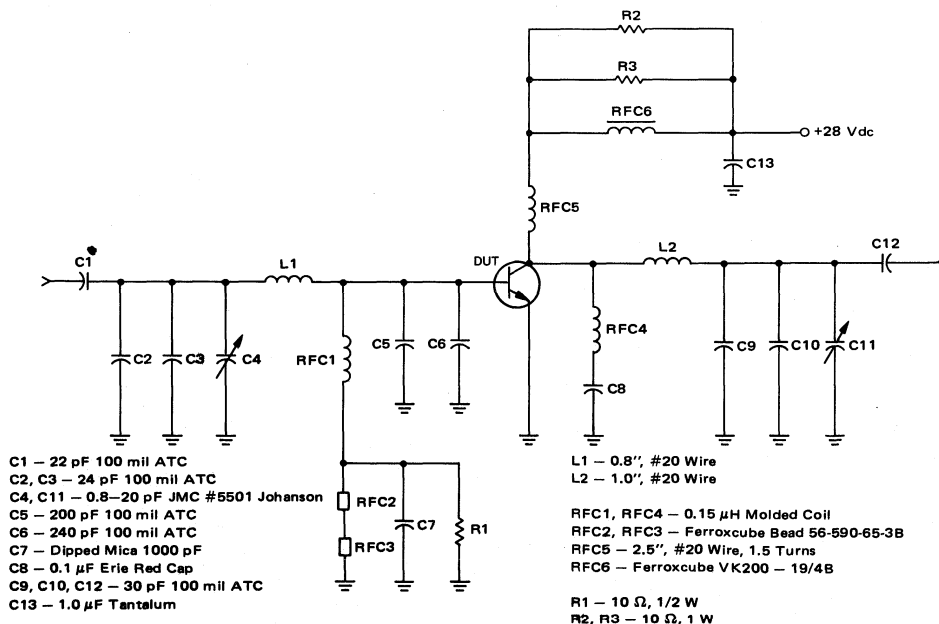
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 4.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	130	200	pF
NARROW BAND FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 150\text{ MHz}$)	G_{pE}	10	13	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 150\text{ MHz}$)	η	55	—	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 80\text{ W CW}$, $f = 150\text{ MHz}$, VSWR 30:1 all phase angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 150 MHz TEST AMPLIFIER



TYPICAL PERFORMANCE CURVES

FIGURE 2 — OUTPUT POWER versus INPUT POWER

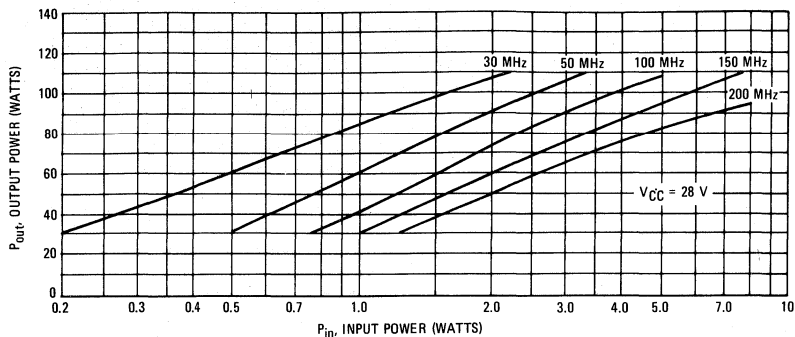


FIGURE 3 — POWER GAIN versus FREQUENCY

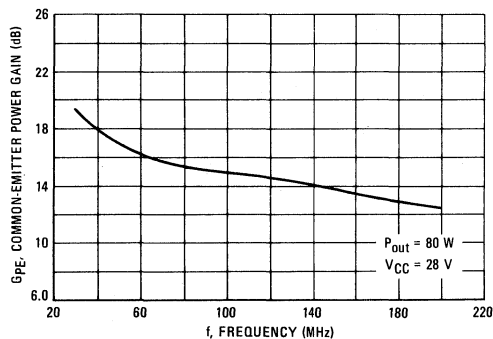
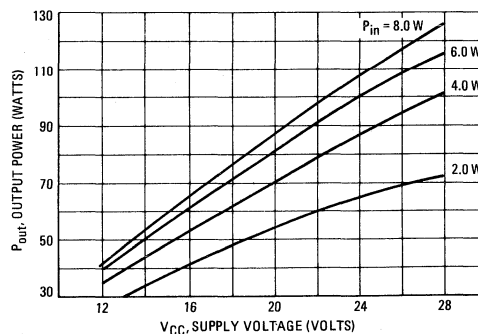
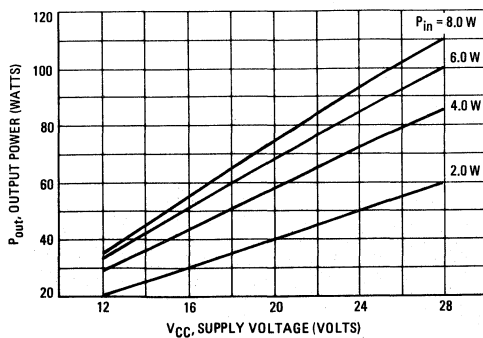
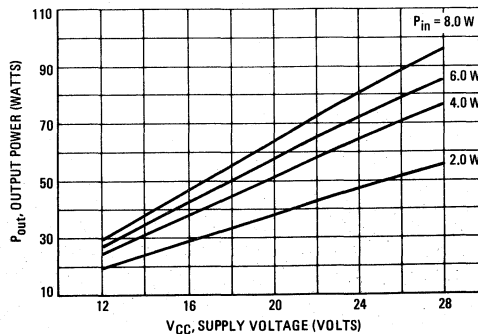
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 100$ MHzFIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 150$ MHzFIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 200$ MHz

FIGURE 7 – SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE

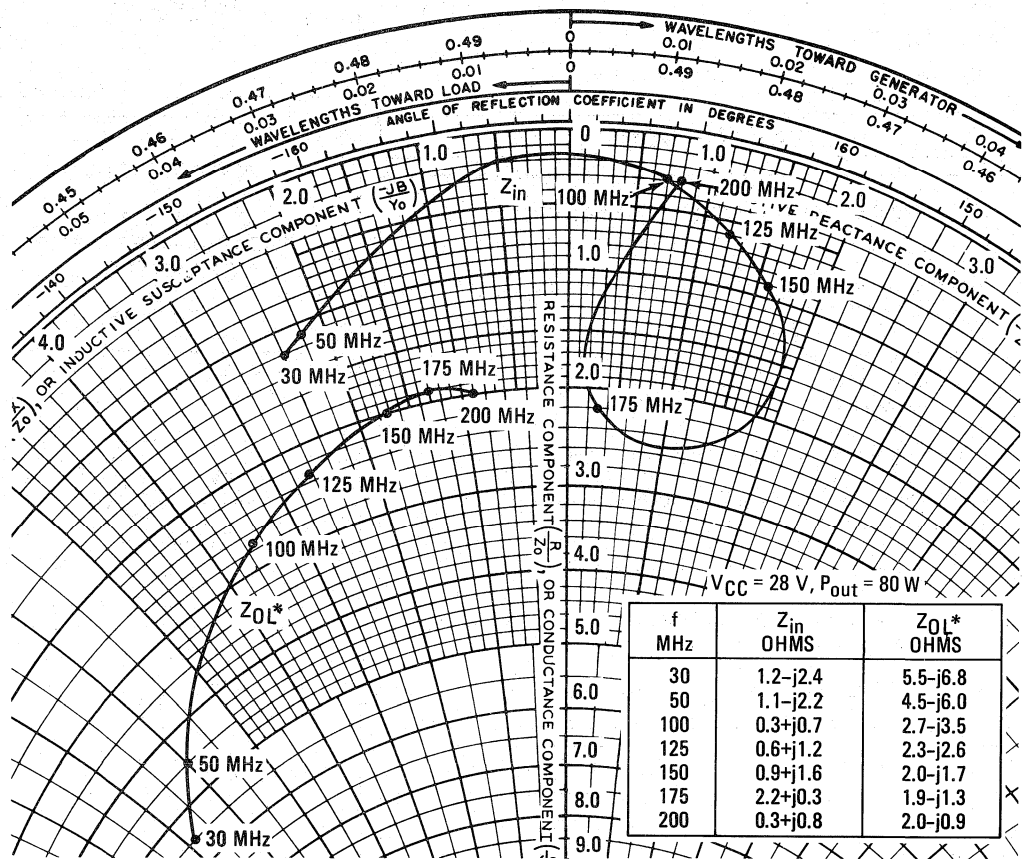
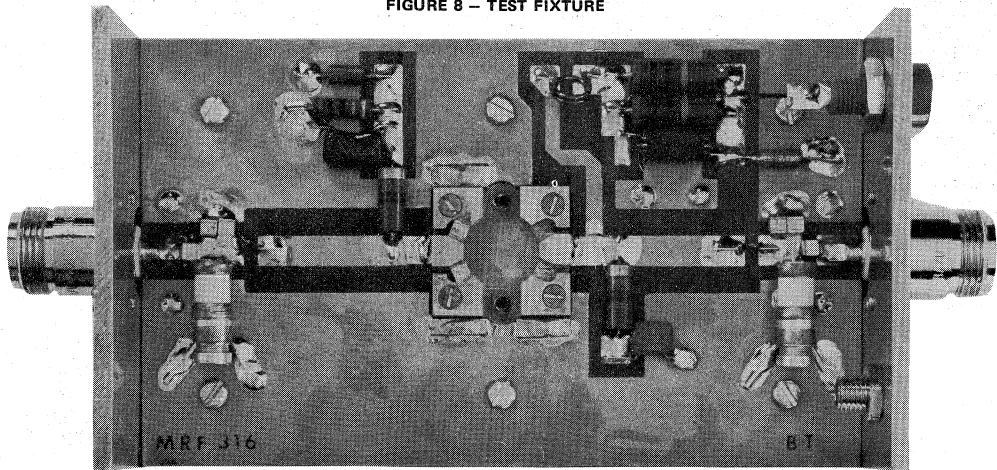


FIGURE 8 – TEST FIXTURE



The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for wideband large signal output amplifier stages in 30–200 MHz frequency range.

- Guaranteed Performance at 150 MHz and 28 Vdc
Output Power = 100 W
Minimum Gain = 9 dB
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability
- High Output Saturation Power — Ideally Suited for 30 W Carrier/120 W Peak AM Amplifier Service
- Guaranteed Performance in Broadband Test Fixture

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	12	Adc
— Peak (10 seconds)		18	
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	270 1.54	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	$^\circ\text{C}/\text{W}$
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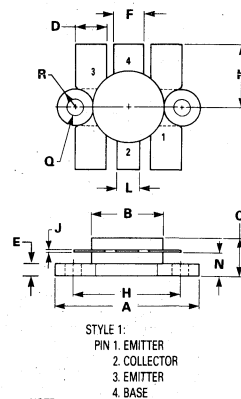
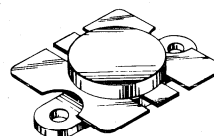
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

MRF317

100 W – 30–200 MHz

**CONTROLLED Q
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON



NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^{\circ}\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	25	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	200	250	pF
FUNCTIONAL TESTS (FIGURE 2)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 100\text{ W}$, $f = 150\text{ MHz}$, $I_C(\text{Max}) = 6.5\text{ Adc}$)	G_{PE}	9.0	10	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 100\text{ W}$, $f = 150\text{ MHz}$, $I_C(\text{Max}) = 6.5\text{ Adc}$)	η	55	60	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 100\text{ W CW}$, $f = 150\text{ MHz}$, $VSWR = 30:1$ all phase angles)	Ψ	No Degradation in Output Power			

FIGURE 1 — BROADBAND (110-160 MHz) TEST FIXTURE

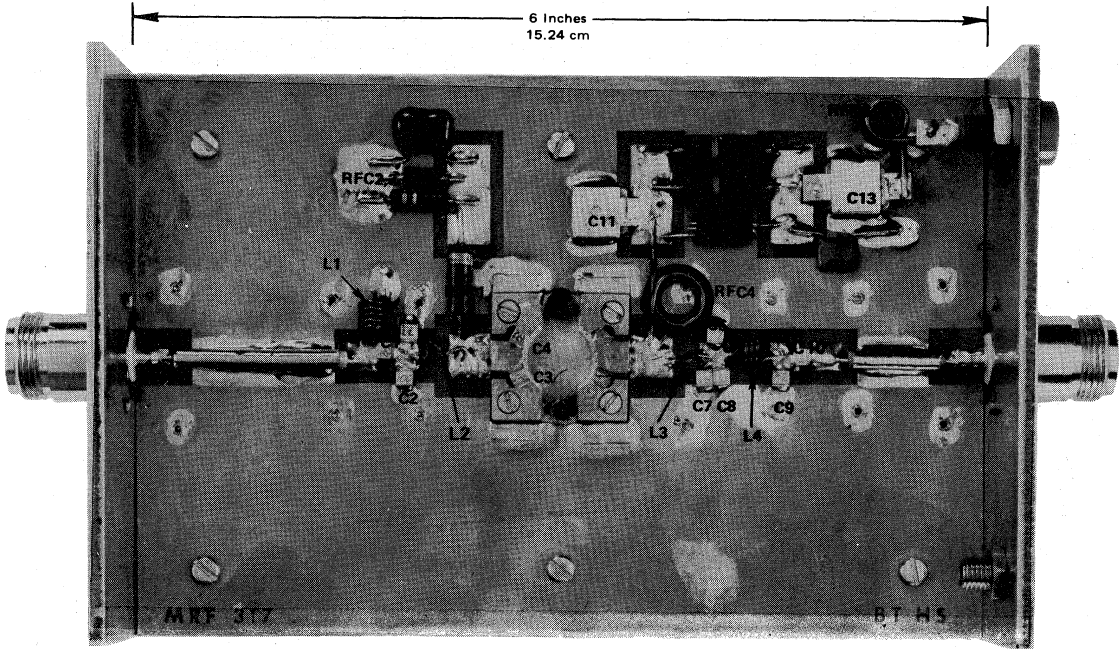
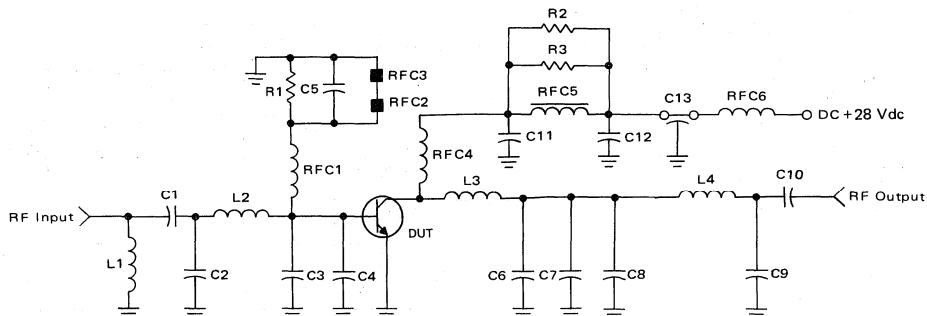
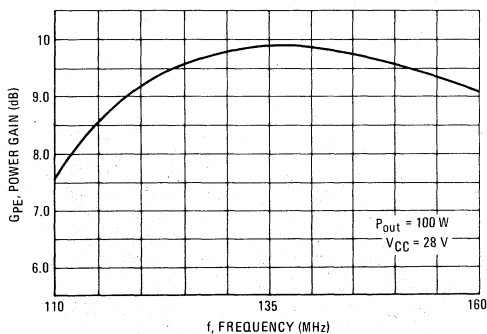
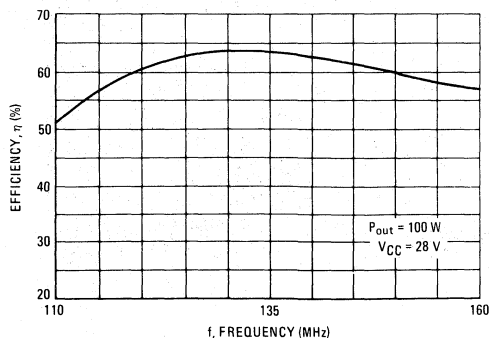
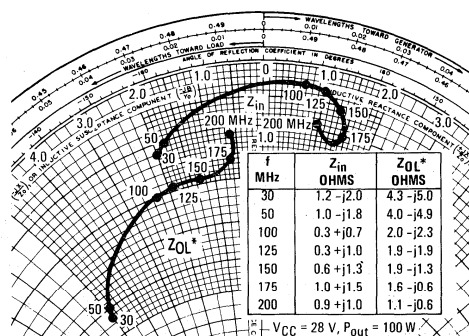


FIGURE 2 — 110-160 MHz BROADBAND AMPLIFIER — TEST FIXTURE

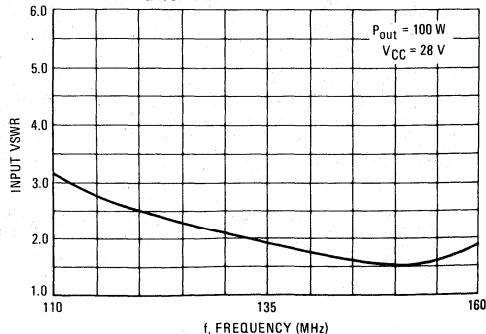


C1, C9 — 39 pF, 100 mil ATC
 C2 — 120 pF, 100 mil ATC
 C3, C4 — 360 pF, 100 mil ATC
 C5 — 1000 pF Dipped Mica
 C6, C7 — 100 pF, 100 mil ATC*
 C8 — 18 pF, 100 mil ATC*
 C10 — 43 pF, 100 mil ATC
 C11 — 60 pF, Underwood
 C12 — 0.1 μ F Erie Redcap
 C13 — 1000 pF, Underwood J102

L1 — 50 nH
 L2 — 6.0 nH
 L3 — 8.0 nH
 L4 — 32 nH
 RFC1 — 0.15 μ H Molded Coil
 RFC2, RFC3 — Ferroxcube Bead 56-590-65/3B
 RFC4 — 1 Turn, #18 Wire, 2.0" L
 RFC5 — Ferroxcube VK200 19/48
 RFC6 — 7 Turns, #18 Wire, 0.3" ID
 R1 — 10 Ω 1/2 W
 R2, R3 — 10 Ω 1 W
 *Combination of C6, C7, C8 equals 220 pF.

FIGURE 3 — POWER GAIN versus FREQUENCY
BROADBAND TEST FIXTUREFIGURE 5 — EFFICIENCY versus FREQUENCY
BROADBAND TEST FIXTUREFIGURE 4 — SERIES EQUIVALENT
INPUT-OUTPUT IMPEDANCE

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 — INPUT VSWR versus FREQUENCY
BROADBAND TEST FIXTURE

TYPICAL PERFORMANCE CURVES

FIGURE 7 – OUTPUT POWER versus INPUT POWER

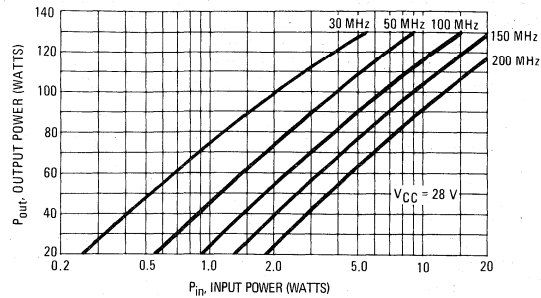
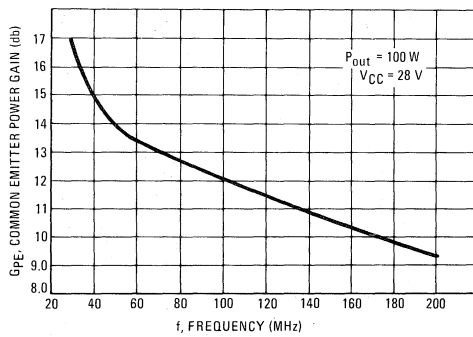
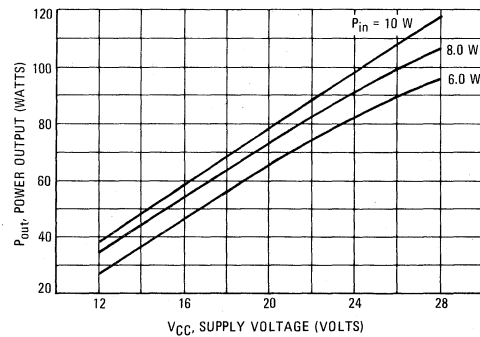
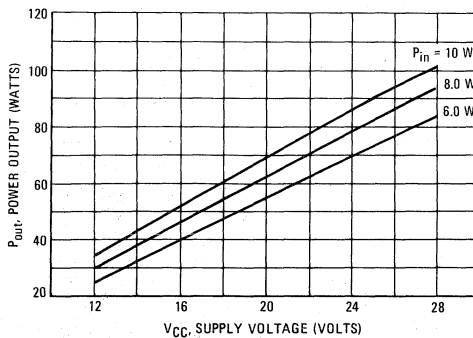
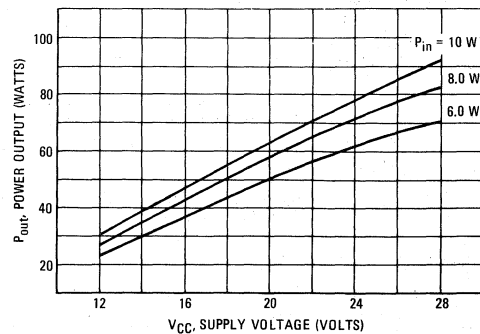


FIGURE 8 – POWER GAIN versus FREQUENCY

FIGURE 9 – POWER OUTPUT versus SUPPLY VOLTAGE
 $f = 100$ MHzFIGURE 10 – POWER OUTPUT versus SUPPLY VOLTAGE
 $f = 150$ MHzFIGURE 11 – POWER OUTPUT versus SUPPLY VOLTAGE
 $f = 200$ MHz

MRF321

The RF Line

NPN SILICON RF POWER TRANSISTOR

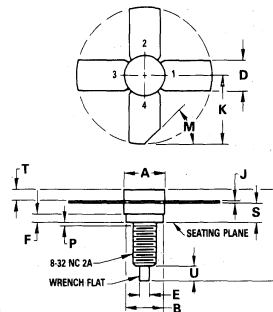
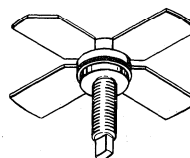
... designed primarily for wideband large-signal driver and predriver amplifier stages in the 200–500 MHz frequency range.

- Guaranteed Performance at 400 MHz and 28 Vdc
Output Power = 10 Watts
Minimum Gain = 12 dB
Efficiency = 50%
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability
- Computer-Controlled Wirebonding Gives Consistent Input Impedance

10 W — 400 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EB0}	4.0	Vdc
Collector Current — Continuous	I_C	1.1	A dc
— Peak		1.5	
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ (1)	P_D	27	Watts
Derate above 25°C		160	mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +150	$^\circ\text{C}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

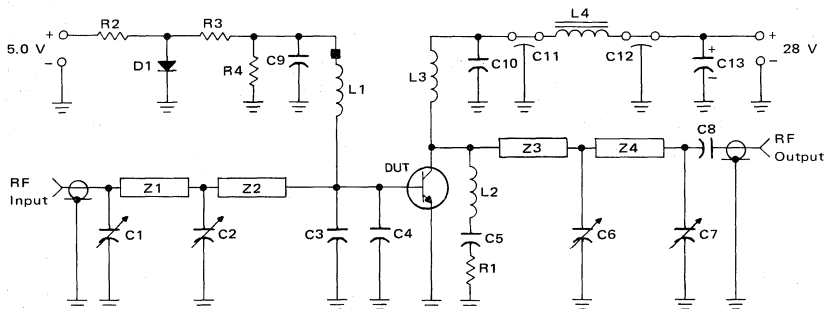
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.4	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter Base Breakdown Voltage ($I_E = 2.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	10	12	pF
FUNCTIONAL TESTS (FIGURE 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 10\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	12	13	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 10\text{ W}$, $f = 400\text{ MHz}$)	η	50	60	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 10\text{ W}$, $f = 400\text{ MHz}$, $V_{SWR} = 30:1$ all phase angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT



C1, C2, C3 — 1.0–20 pF Johanson Trimmer (JMC 5501)
 C3, C4 — 47 pF ATC Chip Capacitor
 C5, C10 — 0.1 μF Erie Redcap
 C7 — 0.5–10 pF Johanson Trimmer (JMC 5201)
 C8 — 0.018 μF Vitramon Chip Capacitor
 C9 — 200 pF UNELCO Capacitor
 C11, C12 — 680 pF Feedthru
 C13 — 1 μF , 50 Volt Tantalum Capacitor

R1 — 5.1 Ω , 1/4 Watt
 R2 — 120 Ω , 1 Watt
 R3 — 20 Ω , 1/2 Watt
 R4 — 47 Ω , 1/2 Watt

L1 — 0.33 μH Molded Choke with Ferroxcube Bead
 (Ferroxcube 56-590-65/4B) on Ground End of Coil

L2 — 4 Turns #20 Enamel, 1/8" ID
 L3 — 6 Turns #20 Enamel, 1/4" ID
 L4 — Ferroxcube VK200-19/4B

Z1 — Microstrip 0.1" W x 1.35" L
 Z2 — Microstrip 0.1" W x 0.55" L
 Z3 — Microstrip 0.1" W x 0.8" L
 Z4 — Microstrip 0.1" W x 1.75" L

D1 — 1N4001

Board — Glass Teflon, $\epsilon_R = 2.56$, $t = 0.062"$

Input/Output Connectors — Type N

FIGURE 2 – OUTPUT POWER versus FREQUENCY

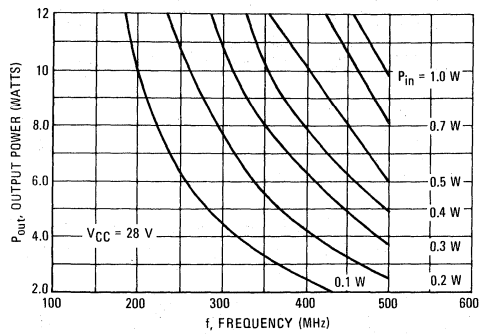


FIGURE 3 – OUTPUT POWER versus INPUT POWER

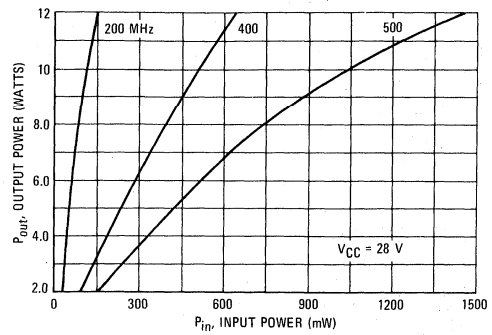


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

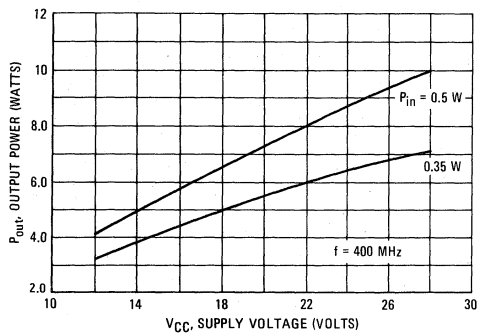


FIGURE 5 – POWER GAIN versus FREQUENCY

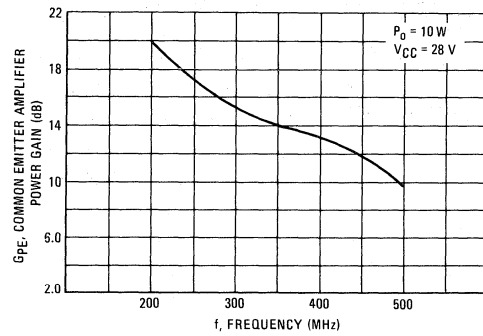
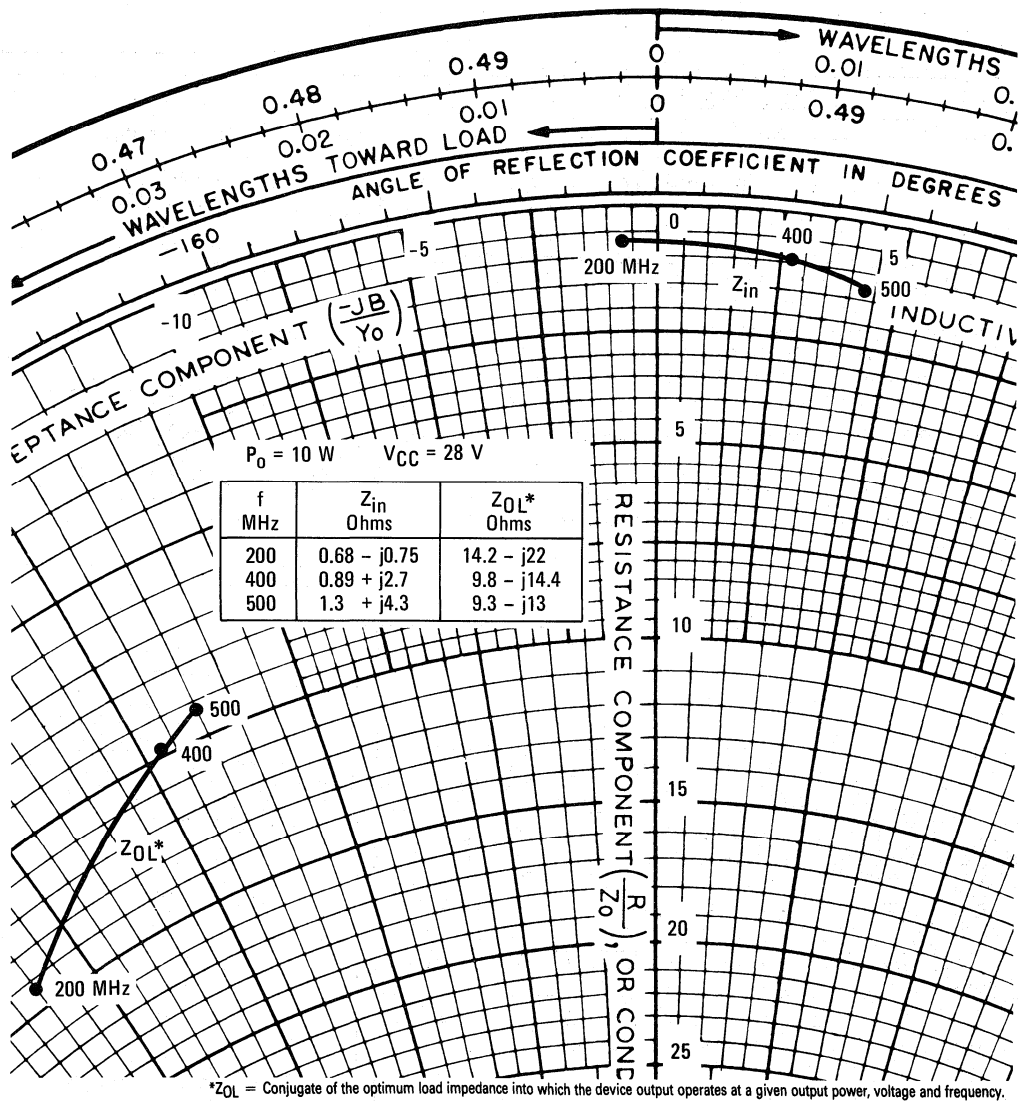


FIGURE 6 – SERIES EQUIVALENT IMPEDANCE



The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for wideband large-signal driver and predriver amplifier stages in the 200-500 MHz frequency range.

- Guaranteed Performance at 400 MHz and 28 V
 Output Power = 20 Watts
 Minimum Gain = 10 dB
 Efficiency = 50%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability
- Computer-Controlled Wirebonding Gives Consistent Input Impedance

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.2	Adc
— Peak		3.0	
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1)	P_D	55	Watts
Derate above 25°C		310	mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

THERMAL CHARACTERISTICS

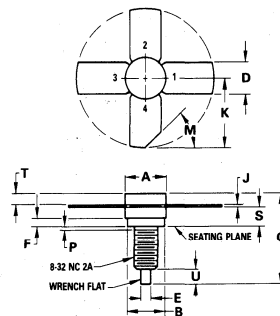
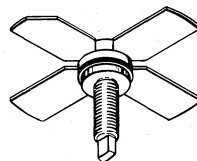
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.2	$^\circ\text{C}/\text{W}$

MRF323

20 W — 400 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:
 PIN 1. EMITTER
 2. BASE
 3. EMITTER
 4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM	45° NOM	—	—
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	2.0	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	—	80	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	20	24	pF
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FUNCTIONAL TESTS (Figure 1)

Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 20\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	10	11	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 20\text{ W}$, $f = 400\text{ MHz}$)	η	50	60	—	%
Load Mismatch ($V_{CC} = 28\text{ V}$, $P_{out} = 20\text{ W}$, $f = 400\text{ MHz}$, $VSWR = 30:1$ all phase angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT

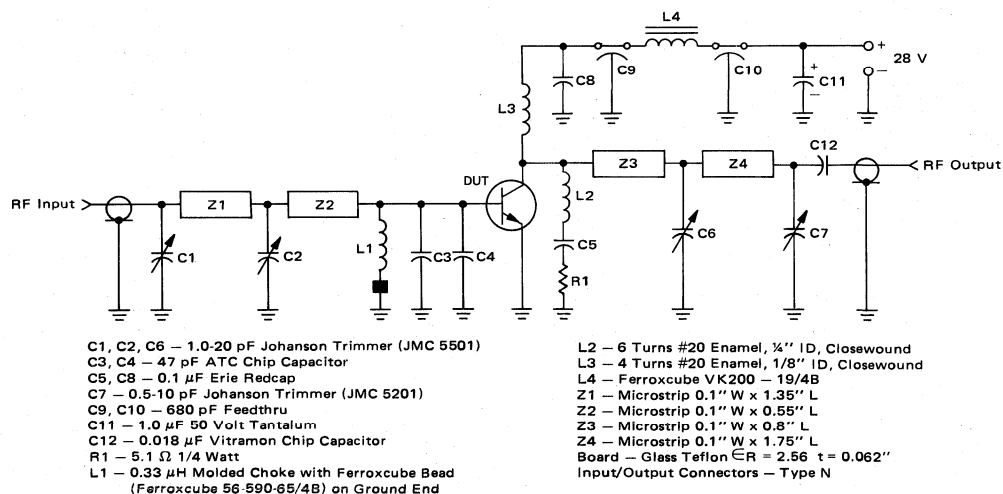


FIGURE 2 – OUTPUT POWER versus FREQUENCY

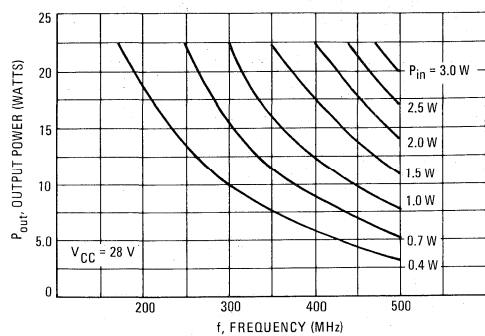


FIGURE 3 – OUTPUT POWER versus INPUT POWER

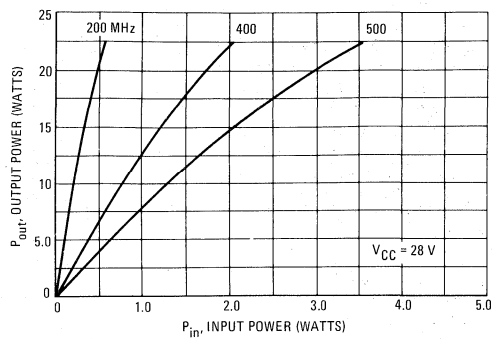


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

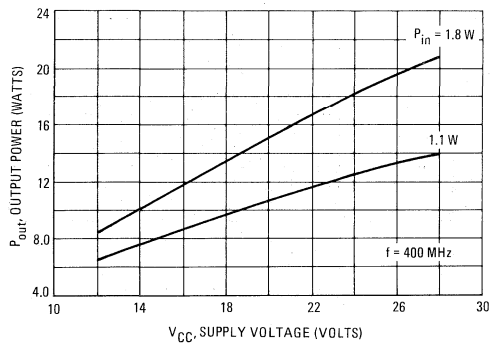


FIGURE 5 – POWER GAIN versus FREQUENCY

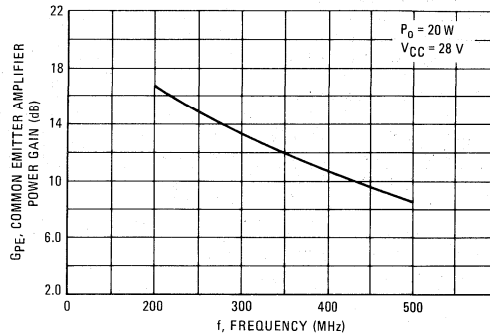
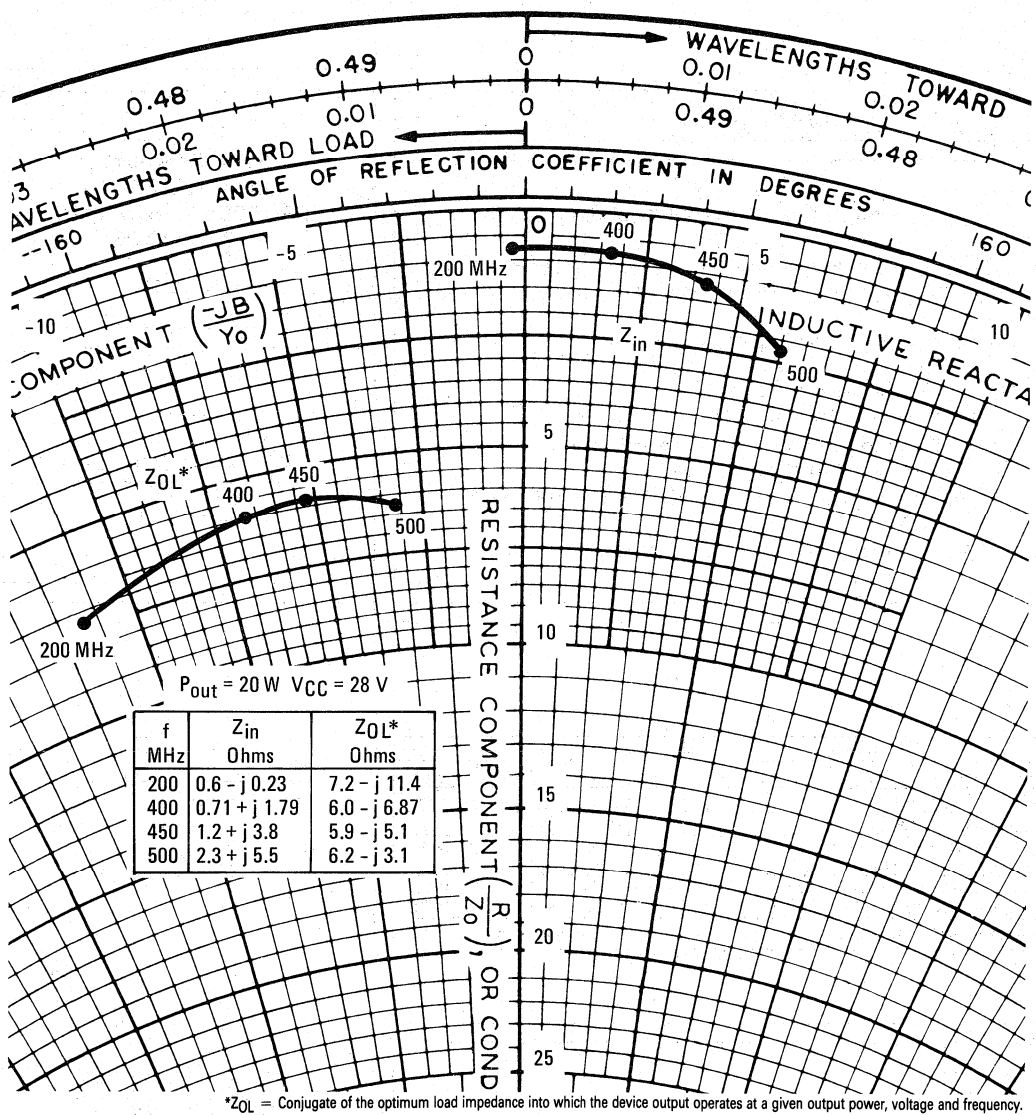


FIGURE 6 — SERIES EQUIVALENT IMPEDANCE



MRF325

The RF Line

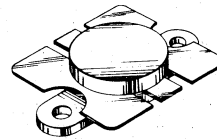
NPN SILICON RF POWER TRANSISTOR

... designed primarily for wideband large-signal output and driver amplifier stages in the 100-500 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
Output Power = 30 Watts
Minimum Gain = 8.5 dB
Efficiency = 54% (Min)
- Built-In Matching Network for Broadband Operation
Using Internal Matching Techniques
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization for High Reliability Applications

**30 W — 225-400 MHz
CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON



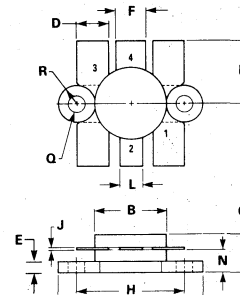
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.4	Adc
— Peak		4.5	
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	82 0.47	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.13	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

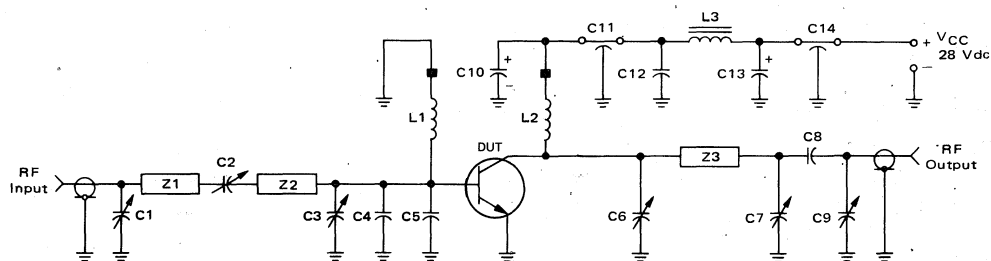
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 3.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 30\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	3.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.5\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	30	40	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	8.5	9.5	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 400\text{ MHz}$)	η	50	60	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 400\text{ MHz}$, $V_{SWR} = 30:1$ all angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT



C1, C9 — 1.0–10 pF Johanson Capacitor (JMC 5201)
 C2, C3, C6, C7 — 1.0–20 pF Johanson Capacitor (JMC 5501)
 C4, C5 — 36 pF ATC 100-mil Chip Capacitor
 C8 — 100 pF UNELCO
 C10, C13 — 1.0 μF 50 V Tantalum
 C11, C14 — 680 pF Feedthru
 C12 — 0.1 μF Erie Redcap
 L1 — 8 Turns #26 AWG Enameled, 1/16" ID Closewound
 with Ferroxcube Bead (#56-590-65/4B) on Ground End

L2 — 14 Turns, #22 AWG Enameled, Closewound on a 470 Ω ,
 2 Watt Resistor with Ferroxcube Bead (#56-590-65/4B)
 on Cold End of L2

L3 — Ferroxcube VK200-19/4B Ferrite Choke

Z1 — Microstrip 0.19" W x 0.88" L

Z2 — Microstrip 0.28" W x 1.0" L

Z3 — Microstrip 0.31" W x 1.25" L

Board — Glass Teflon $\epsilon_R = 2.56$, $t = 0.062$ "

Input/Output Connectors — Type N

DUT Socket Lead Frame Etched from 80-mil-Thick Copper

FIGURE 2 – OUTPUT POWER versus INPUT POWER

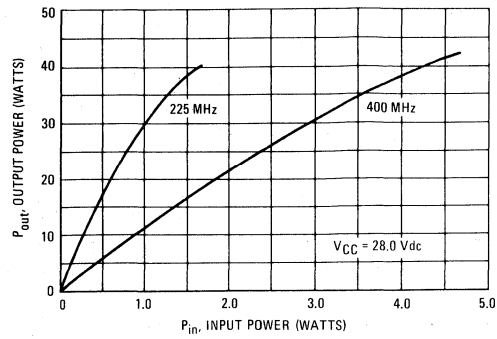


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE – 225 MHz

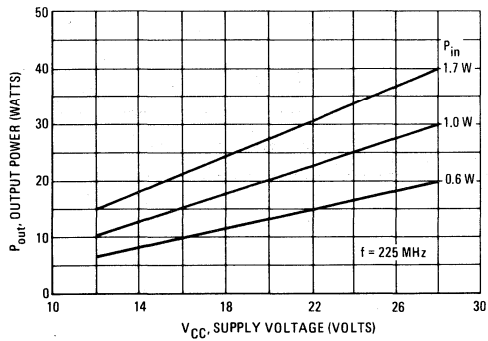


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE – 400 MHz

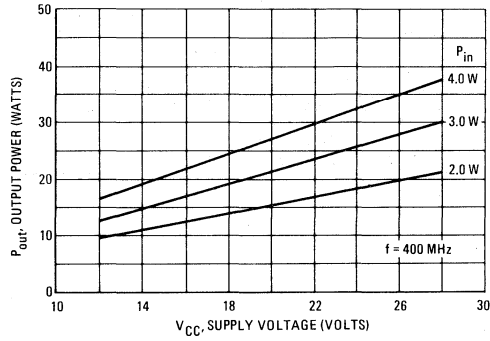
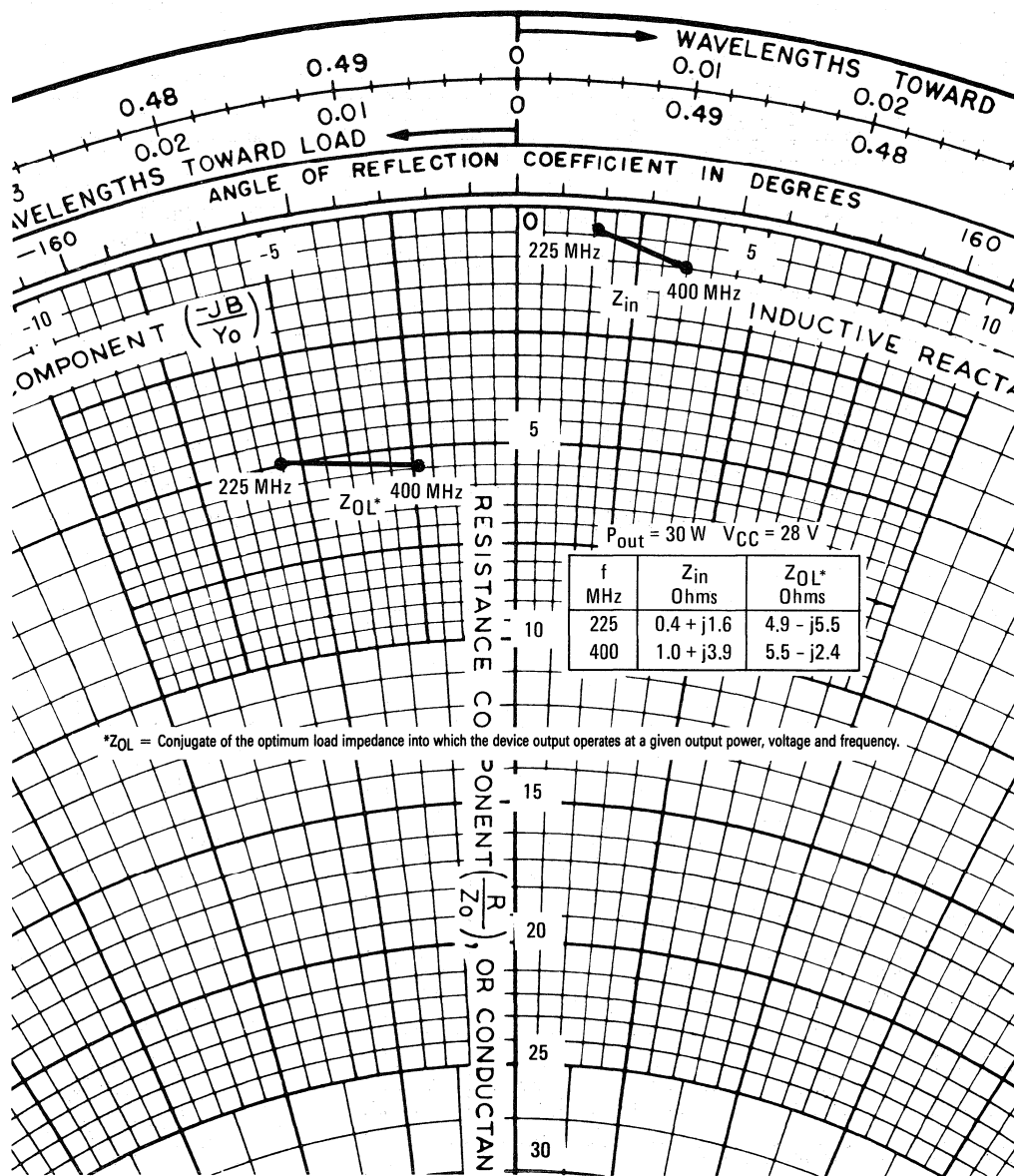


FIGURE 5 — SERIES EQUIVALENT IMPEDANCE



MRF326

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for wideband large-signal output amplifier stages in the 100-500 MHz frequency range.

- Guaranteed Performance @ 400 MHz, 28 Vdc

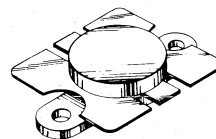
Output Power = 40 Watts
Minimum Gain = 9.0 dB

- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

40 W — 225–400 MHz

**CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON



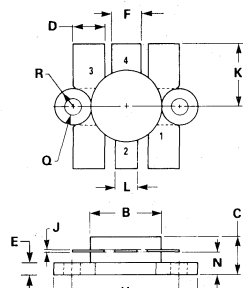
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.5	Adc
Peak		6.0	
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1)	P_D	110	Watts
Derate above 25°C		0.63	W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.6	$^\circ\text{C}/\text{W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

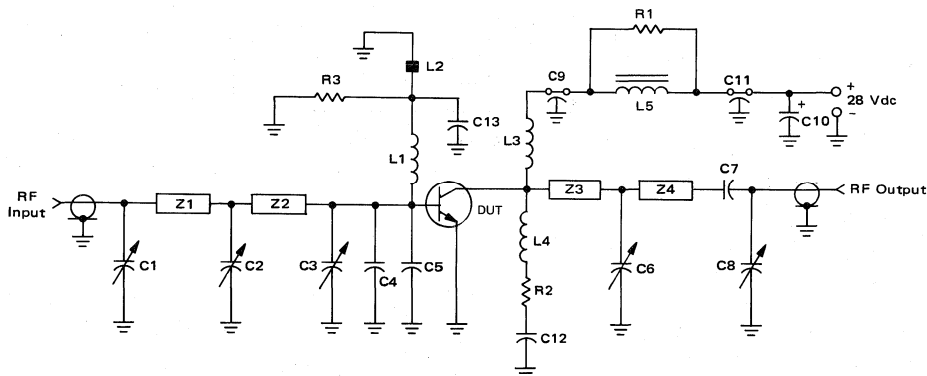
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.95	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 40\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 40\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 4.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 40\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	4.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	50	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	45	60	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W}$, $f = 400\text{ MHz}$, $I_C\text{ Max} = 2.85\text{ Adc}$)	G_{PE}	9.0	11	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W}$, $f = 400\text{ MHz}$, $I_C\text{ Max} = 2.85\text{ Adc}$)	η	50	—	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W CW}$, $f = 400\text{ MHz}$, VSWR = 30:1 all phase angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 400 MHz TEST AMPLIFIER



C1 — 1.0–10 pF Johanson, Capacitor (JMC 5201)
 C2, C3, C6, C8 — 1.0–20 pF Johanson Capacitor
 C4, C5 — 36 pF ATC "B" Style Chip Capacitor
 C7, C9, C13 — 100 pF UNELCO Capacitor
 C11 — 680 pF Feedthru
 C10 — 1.0 μF 50 V Tantalum
 C12 — 0.1 μF Erie Redcap
 L1 — 8 Turns #26 AWG Enameled, 1/16" ID Closewound
 L2, L5 — Ferroxcube VK200–19/4B Ferrite Choke

L3 — 8 Turns #20 AWG Enameled, 1/4" ID Closewound
 L4 — 4 Turns #26 AWG 0.1" ID
 R1 — 10 Ohm 2.0 W Carbon
 R2, R3 — 10 Ohm 1.0 W Carbon
 Z1 — Microstrip 0.19" W x 1.28" L
 Z2 — Microstrip 0.28" W x 1.0" L
 Z3 — Microstrip 0.31" W x 1.0" L
 Z4 — Microstrip 0.31" W x 0.9" L
 Board — Glass Teflon $\epsilon_R = 2.56$ $t = 0.062"$
 Input/Output Connectors — Type N UG58 A/U

FIGURE 2 – OUTPUT POWER versus INPUT POWER

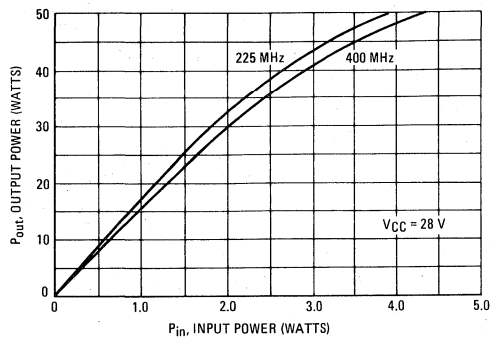
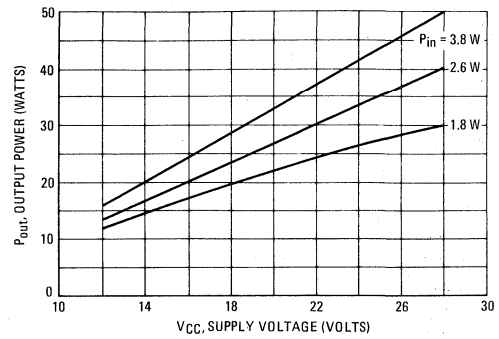
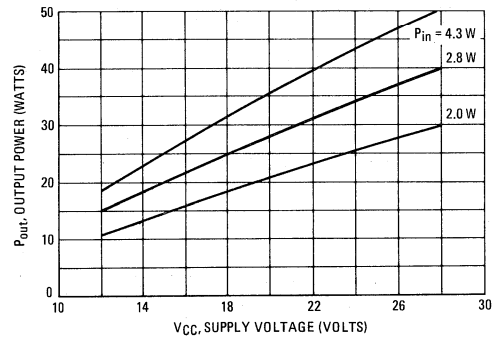
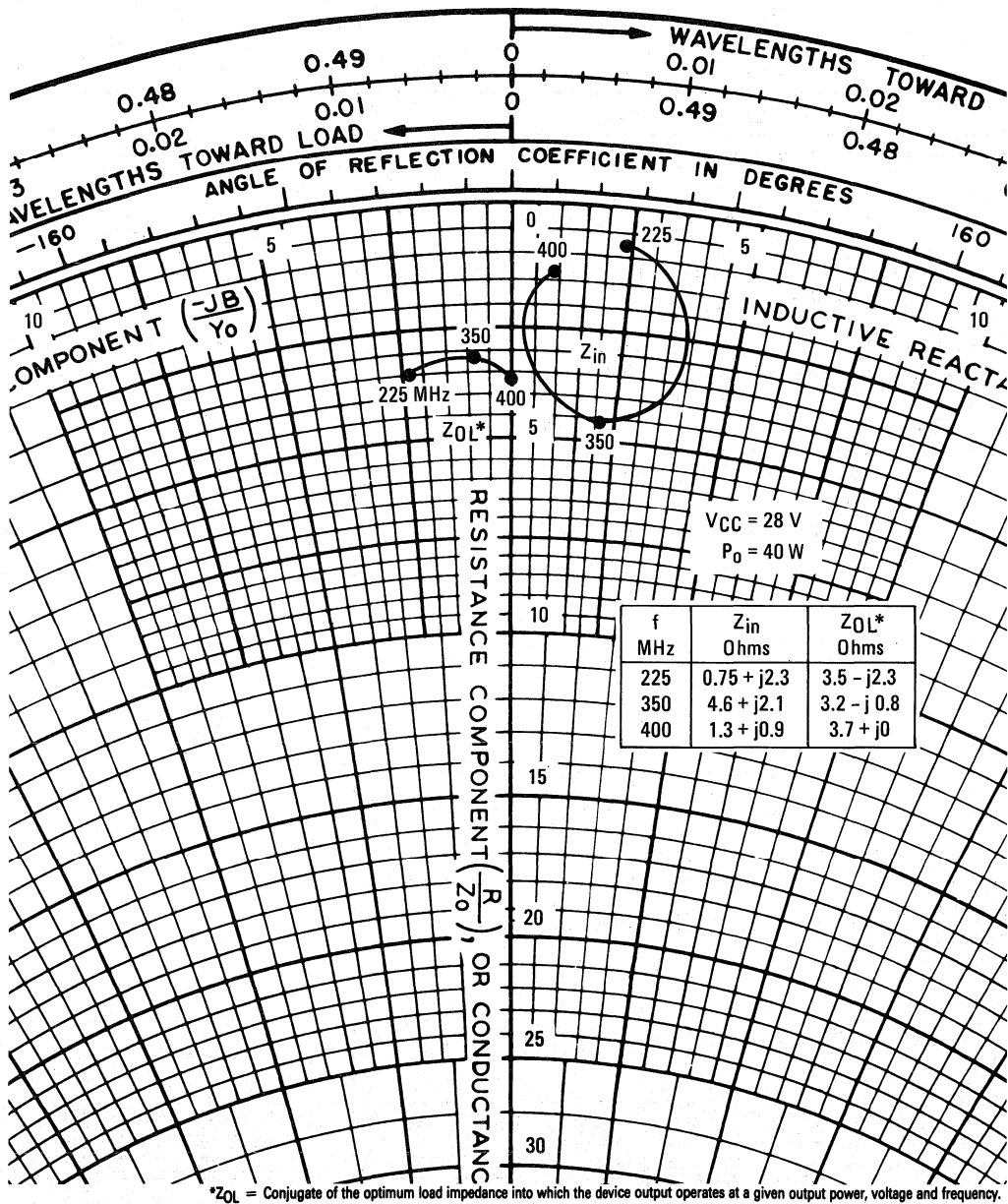
FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 225\text{ MHz}$ FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 400\text{ MHz}$ 

FIGURE 5 - SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



MRF327

The RF Line

NPN SILICON RF POWER TRANSISTOR

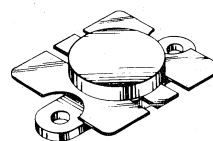
... designed primarily for wideband large-signal output amplifier stages in the 100-500 MHz frequency range.

- Guaranteed Performance @ 400 MHz, 28 Vdc
Output Power = 80 Watts over 225–400 MHz Band
Minimum Gain = 7.3 dB @ 400 MHz
- Built-in Matching Network for Broadband Operation Using Double Match Technique
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications
- Characterized for 100–500 MHz

80 W – 100-500 MHz

**CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON



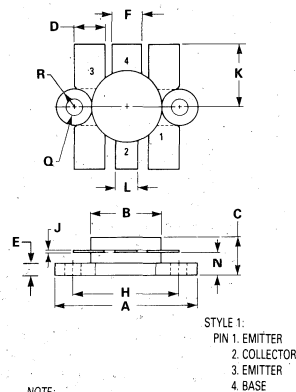
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	33	Vdc
Collector-Base Voltage	V_{CB0}	60	Vdc
Emitter-Base Voltage	V_{EB0}	4.0	Vdc
Collector Current – Continuous – Peak	I_C	9.0 12.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	250 1.43	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 80\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 80\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 8.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 80\text{ mAdc}$, $I_C = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5.0	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 4.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	—	80	—
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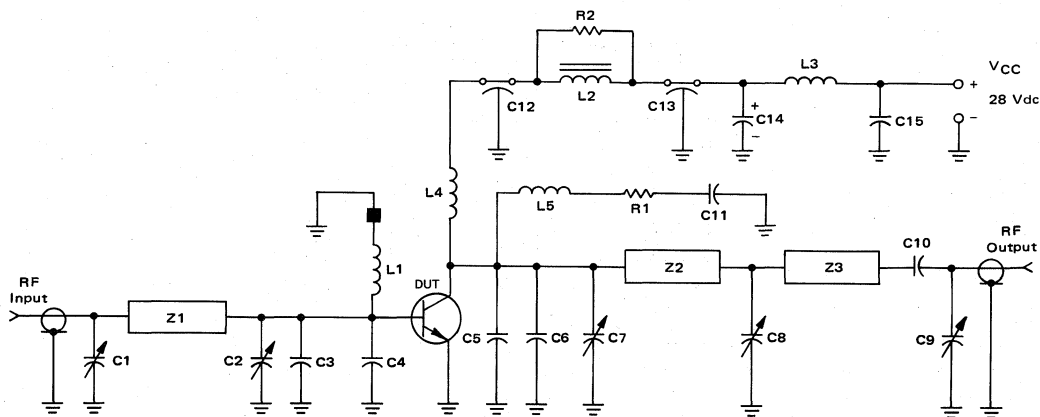
DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	100	145	pF
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FUNCTIONAL TESTS (Figure 1)

Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	7.3	9.0	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 400\text{ MHz}$)	η	50	60	—	%
Load Mismatch ($V_{CC} = 28\text{ V}$, $P_{out} = 80\text{ W}$, $f = 400\text{ MHz}$, VSWR 30:1 all phase angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT



C1, C2, C7, C8, C9 — 1.0-20 pF Piston Trimmer (Johanson JMC 5501)
 C3, C4 — 36 pF ATC 100 mil Chip Capacitor
 C5, C6 — 43 pF ATC 100-mil Chip Capacitor
 C10 — 100 pF UNELCO
 C11, C15 — 0.1 μF Erie Redcap
 C12, C13 — 680 pF Feedthru
 C14 — 1.0 μF 50 V Tantalum
 L1 — 4 Turns #22 AWG Enameled, 3/16" ID Closewound with Ferroxcube Bead (#56-590-65/4B) on Ground End of Coil
 L2 — Ferroxcube VK200-19/4B Ferrite Choke
 L3 — 7 Turns #18 AWG, 11/16" Long, Wound on a 100 k Ω 2 Watt Resistor

L4 — 6 Turns #20 AWG Enameled, 3/16" ID Closewound
 L5 — 4 Turns #22 AWG Enameled, 1/8" ID Closewound
 Z1 — Microstrip 0.2" W x 1.5" L
 Z2 — Microstrip 0.17" W x 1.16" L
 Z3 — Microstrip 0.17" W x 0.63" L
 R1, R2 — 10 Ω 2 Watt
 Board — Glass Teflon $\epsilon_R = 2.56$, $t = 0.062$ "
 Input/Output Connectors Type N

DUT Socket Lead Frame Etched from 80-mil-Thick Copper

FIGURE 2 — POWER GAIN versus FREQUENCY

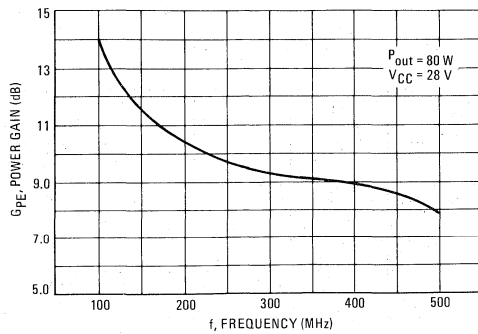


FIGURE 3 — OUTPUT POWER versus FREQUENCY

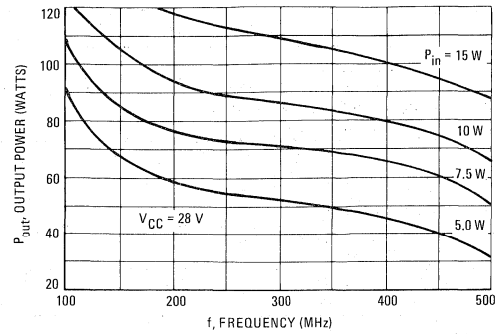
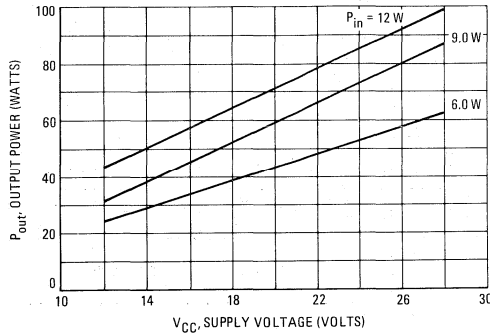
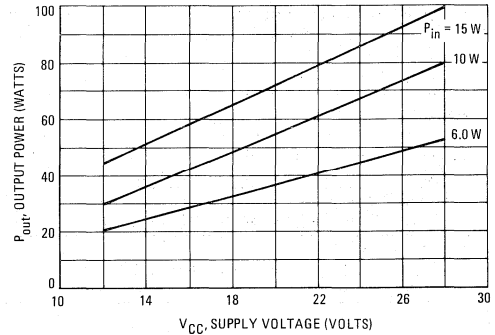
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 225\text{ MHz}$ FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 400\text{ MHz}$ 

FIGURE 6 — OUTPUT POWER versus INPUT POWER

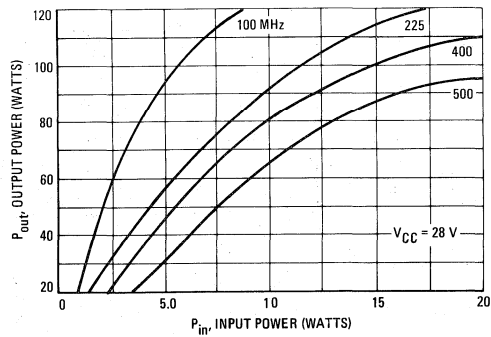
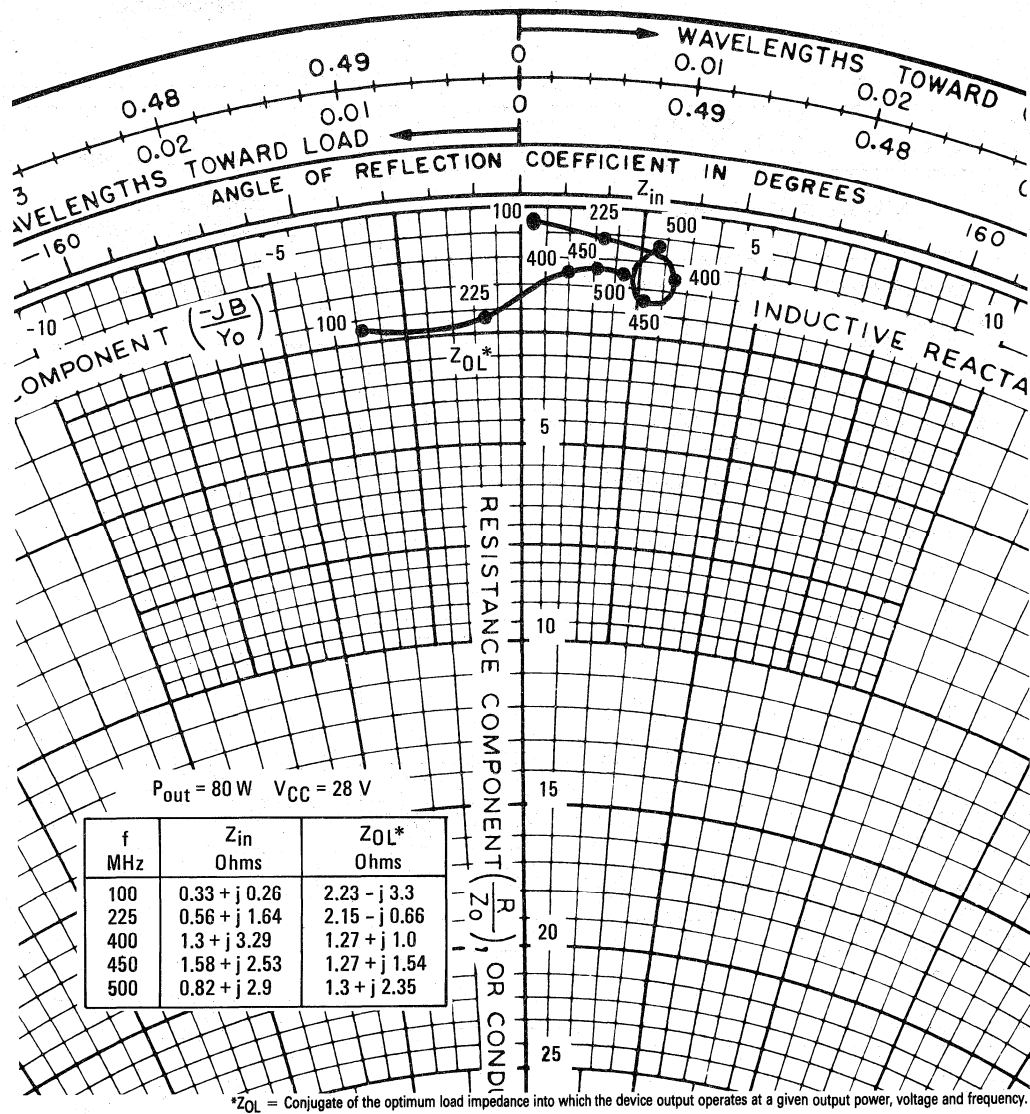


FIGURE 7 — SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



MRF329

The RF Line

NPN SILICON RF POWER TRANSISTOR

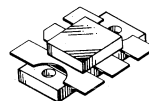
... designed primarily for wideband large-signal output and driver amplifier stages in the 100–500 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
Output Power = 100 Watts
Minimum Gain = 7.0 dB
Efficiency = 50% (Min)
- Built-In Matching Network for Broadband Operation
Using Double Match Technique
- 100% Tested for Load Mismatch at All Phase Angles
With 3:1 VSWR
- Gold Metallization System for High Reliability
- Replacement for MRF328

100 W — 100–500 MHz

**CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON



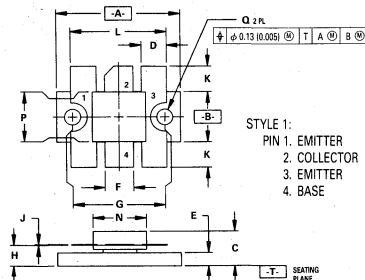
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	9.0	Adc
— Peak		12.0	
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1)	P_D	270	Watts
Derate above 25°C		1.54	$\text{W}/^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	0.65	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

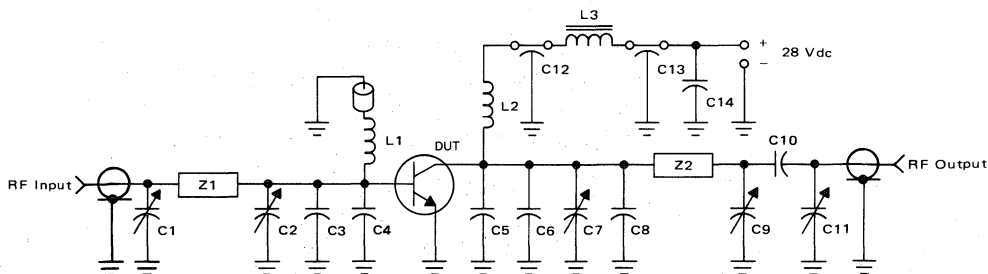
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.51	25.02	0.965	0.985
B	9.91	10.41	0.390	0.410
C	6.73	7.24	0.265	0.285
D	4.83	5.33	0.190	0.210
E	2.42	2.92	0.095	0.115
F	5.47	5.96	0.215	0.235
G	18.42 BSC		0.725 BSC	
H	3.94	4.44	0.155	0.175
J	0.10	0.15	0.004	0.006
K	4.95	5.21	0.195	0.205
L	18.80	19.55	0.740	0.770
N	10.54	10.80	0.415	0.425
P	9.91	10.16	0.390	0.400
Q	3.05	3.42	0.120	0.135

CASE 333-03

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 80 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 80 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 8.0 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 80 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 4.0 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	95	125	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28 \text{ Vdc}$, $P_{out} = 100 \text{ W}$, $f = 400 \text{ MHz}$)	G_{pE}	7.0	9.7	—	dB
Collector Efficiency ($V_{CC} = 28 \text{ Vdc}$, $P_{out} = 100 \text{ W}$, $f = 400 \text{ MHz}$)	η	50	60	—	%
Load Mismatch ($V_{CC} = 28 \text{ Vdc}$, $P_{out} = 100 \text{ W}$, $f = 400 \text{ MHz}$ VSWR = 3:1 all angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT



C1, C2, C7, C9 — 1.0–20 pF Johanson (JMC 5501)
 C3, C4 — 36 pF 100 mil Chip Cap (ATC)
 C5, C6 — 50 pF 100 mil Chip Cap (ATC)
 C8 — 30 pF 100 mil Chip Cap (ATC)
 C10 — 2-150 pF 100 mil Chip Caps in Parallel (ATC)
 C11 — 1.0-10 pF Johanson (JMC 5201)
 C12, C13 — 1000 pF UNELCO Feedthru
 C14 — 0.1 μF Erie Redcap

L1 — 0.15 μH Molded Choke with Ferrite Bead
 (Ferroxcube #56-590-65/4B) on Ground End
 L2 — 4 Turns #18 AWG, 1/4" ID
 L3 — Ferroxcube VK200-19/4B
 Z1 — Microstrip Line 2300 mils L \times 210 mils W
 Z2 — Microstrip Line 2300 mils L \times 280 mils W
 Board — Glass Teflon, $t = 0.062''$, $\epsilon_r = 2.56$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

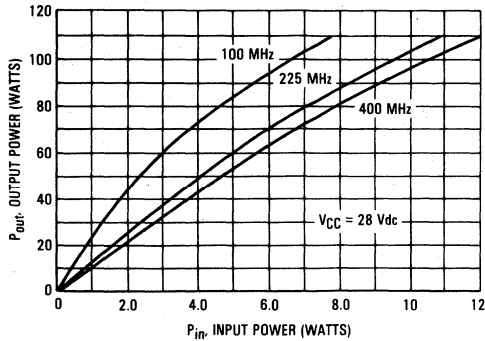


FIGURE 3 — OUTPUT POWER versus FREQUENCY

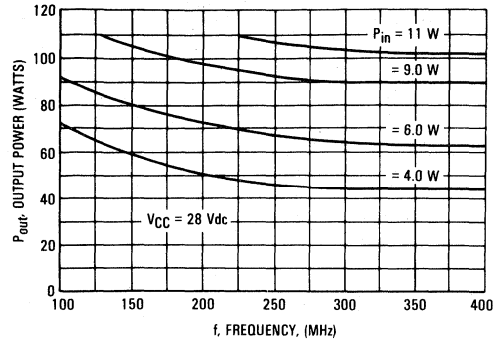


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE (225 MHz)

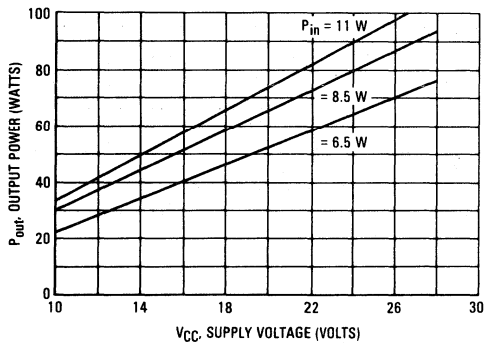


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE (400 MHz)

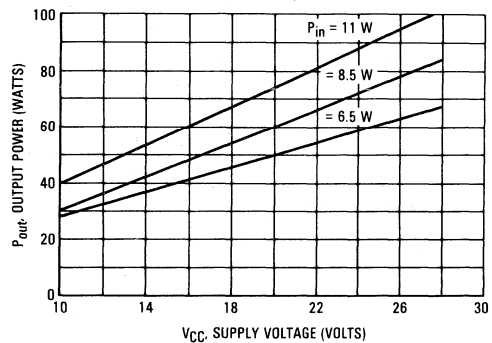


FIGURE 6 — POWER GAIN versus FREQUENCY

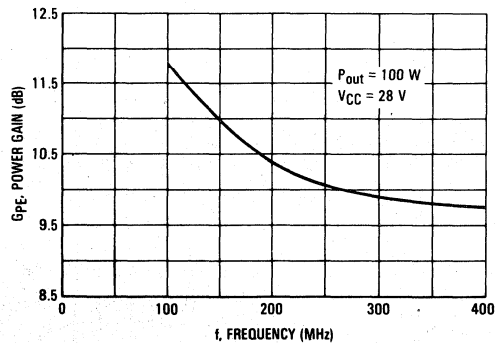


FIGURE 7 — SERIES EQUIVALENT INPUT/
OUTPUT IMPEDANCE

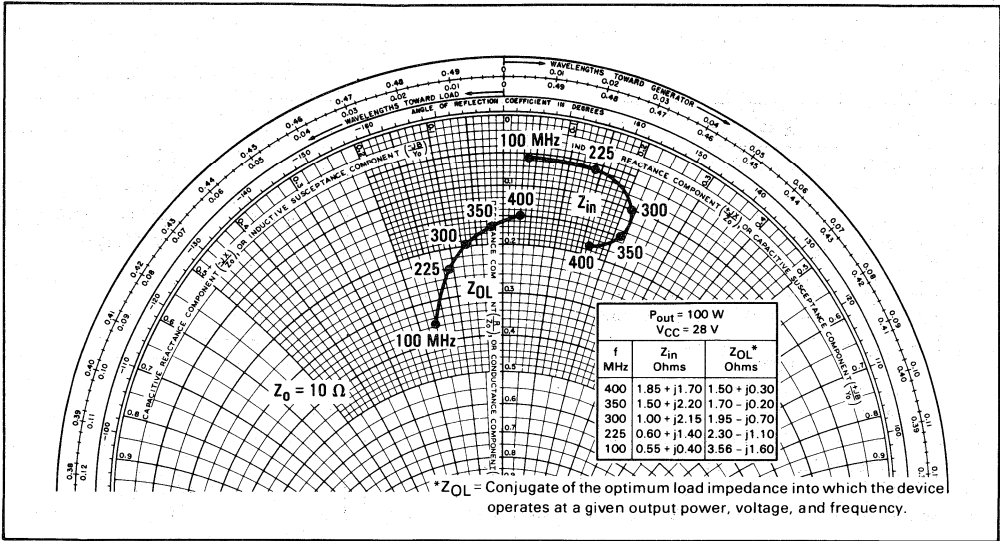
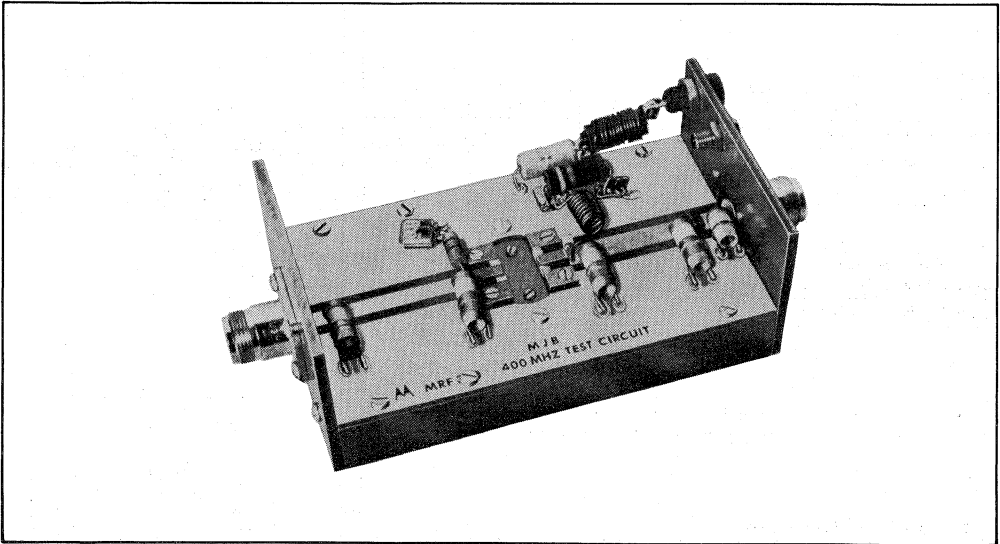


FIGURE 8 — TEST FIXTURE



MRF338

The RF Line

NPN SILICON RF POWER TRANSISTOR

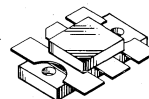
... designed primarily for wideband large-signal output and driver amplifier stages in the 400–512 MHz frequency range.

- Specified 28 Volt, 470 MHz Characteristics —
Output Power = 80 Watts
Minimum Gain = 7.3 dB
Efficiency = 50% (Min)
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at All Phase Angles With 30:1 VSWR
- Gold Metallization System for High Reliability Applications

80 W — 400–512 MHz

**CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON



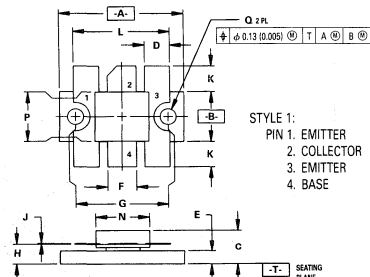
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	30	V _{dc}
Collector-Base Voltage	V _{CBO}	60	V _{dc}
Emitter-Base Voltage	V _{EBO}	4.0	V _{dc}
Collector Current — Continuous — Peak	I _C	9.0 12.0	A _{dc}
Total Device Dissipation @ T _C = 25°C (1) Derate above 25°C	P _D	250 1.43	Watts W/°C
Storage Temperature Range	T _{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	R _{θJC}	0.7	°C/W

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



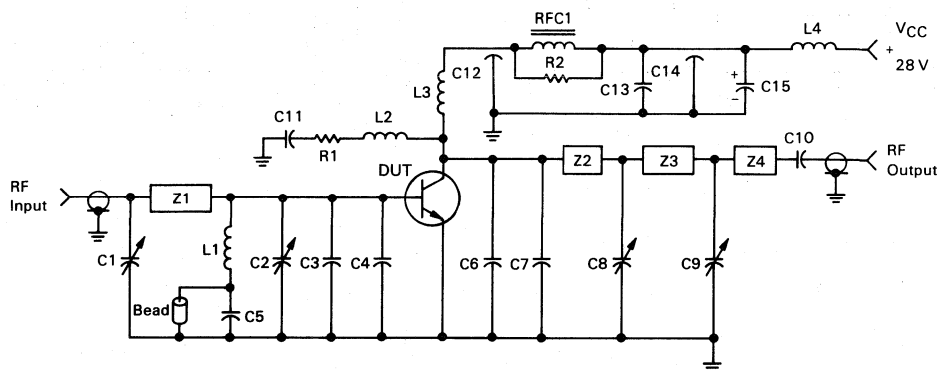
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.51	25.02	0.965	0.985
B	9.91	10.41	0.390	0.410
C	6.73	7.24	0.265	0.285
D	4.83	5.33	0.190	0.210
E	2.42	2.92	0.095	0.115
F	5.47	5.96	0.215	0.235
G	18.42 BSC		0.725 BSC	
H	3.94	4.44	0.155	0.175
J	0.10	0.15	0.004	0.006
K	4.95	5.21	0.195	0.205
L	18.80	19.55	0.740	0.770
N	10.54	10.80	0.415	0.425
P	9.91	10.16	0.390	0.400
Q	3.05	3.42	0.120	0.135

CASE 333-03

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 80\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 80\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 8.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 80\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 4.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	95	125	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 470\text{ MHz}$)	G_{PE}	7.3	8.8	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 470\text{ MHz}$)	η	50	60	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 470\text{ MHz}$, $V_{SWR} = 30:1$ all angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 470 MHz TEST CIRCUIT

C1, C2, C8, C9 — 0.8–20 pF Johanson (JMC 5501)
 C3, C4, C6, C7 — 25 pF Underwood 100 V
 C5, C10 — 100 pF Underwood 100 V
 C11, C13 — 0.1 μF Erie Redcap
 C12, C14 — 680 pF Feedthru
 C15 — 1.0 μF Tantalum
 L1 — 0.15 μH Molded Choke
 L2 — 5 Turns #20 AWG, 0.185" ID, Close Wound
 L3 — 3 Turns #18 AWG, 0.185" ID, Close Wound
 L4 — 4 Turns #18 AWG, 0.185" ID, Close Wound

RFC1 — Ferroxcube VK200 19/4B
 Bead — Ferroxcube #56-590-65/3B
 R1, R2 — 10 Ω 2.0 Watt Carbon
 Z1 — Microstrip Line 0.190" W \times 2.5" L
 Z2 — Microstrip Line 0.190" W \times 0.289" L
 Z3 — Microstrip Line 0.190" W \times 0.55" L
 Z4 — Microstrip Line 0.190" W \times 0.325" L
 Board — Glass Teflon, $\epsilon_r = 2.56$, $t = 0.062"$

FIGURE 2 — POWER OUTPUT versus POWER INPUT

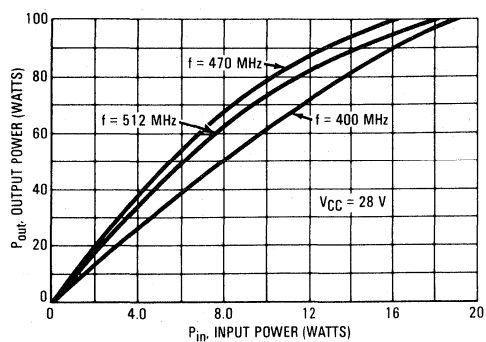


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

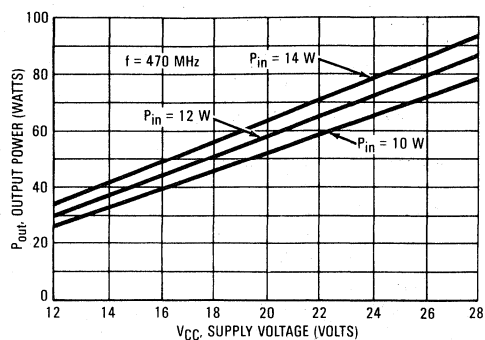


FIGURE 4 — POWER GAIN versus FREQUENCY

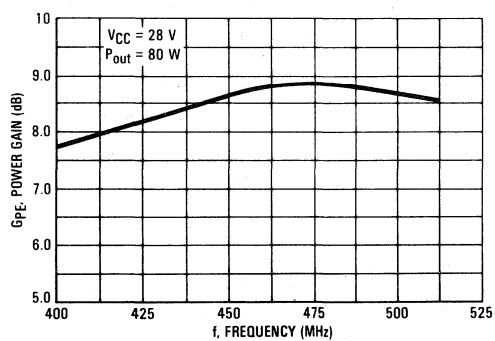


FIGURE 5 — OUTPUT POWER versus FREQUENCY

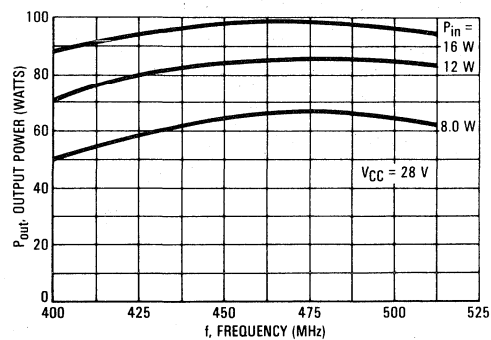
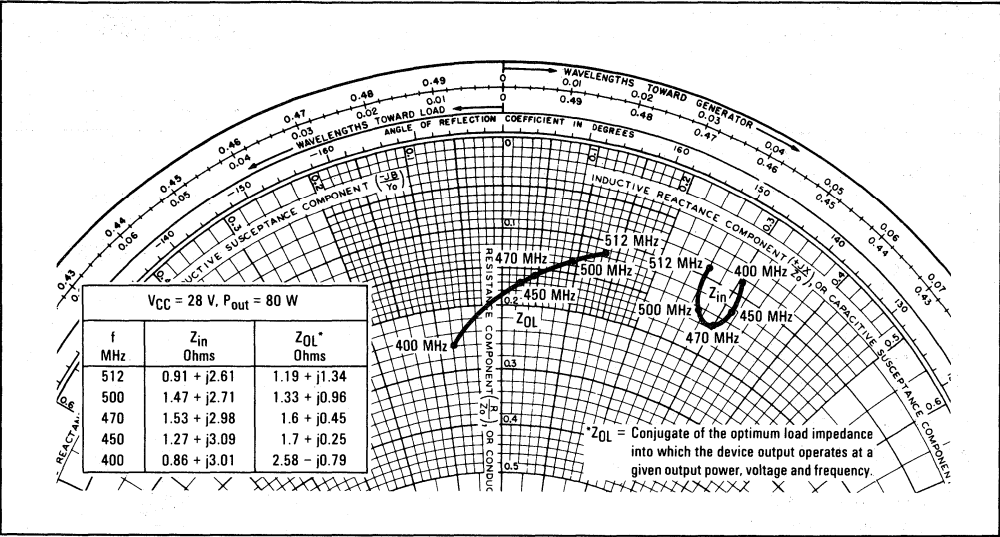
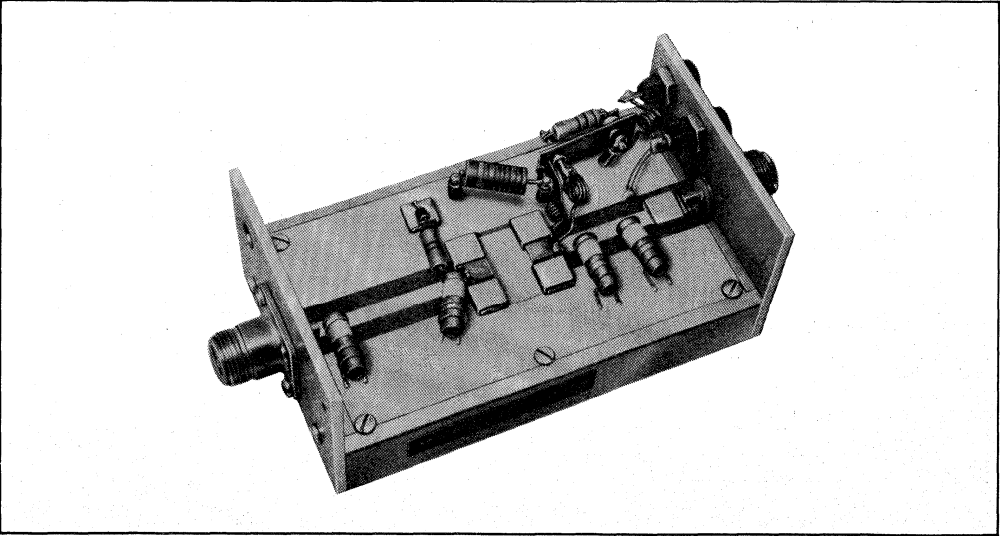


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



2

FIGURE 7 — TEST FIXTURE



The RF Line

NPN SILICON RF POWER TRANSISTOR

...designed primarily for use in VHF amplifiers with amplitude modulation and other communications equipment operating to 150 MHz.

- Low Cost Common Emitter TO-220 Package
- Specified 27 V, 136 MHz Performance:
 - Output Power = 8.0 W
 - Power Gain = 13 dB Min
 - Efficiency = 50% Min
- 20:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage
- Other Devices in the Series:
 - MRF342 24 W
 - MRF344 60 W

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current - Continuous	I_C	1.0	Adc
Peak		1.2	
Total Device Dissipation - $T_C = 25^\circ\text{C}$ (1)	P_D	15	Watts
Derate above 25°C		86	mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	11.6	$^\circ\text{C}/\text{W}$

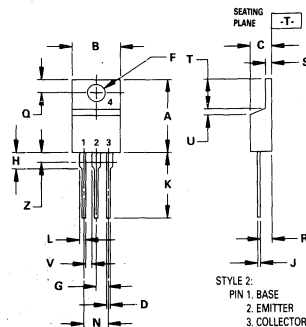
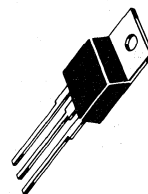
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

MRF340

8 W 100-150 MHz

RF POWER TRANSISTOR

NPN SILICON



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

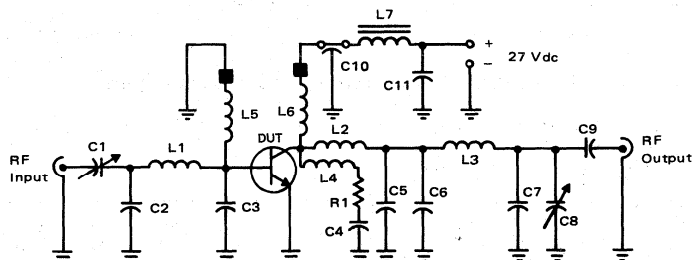
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	3.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 27\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CD} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 27\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	8.0	15	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 13.5\text{ Vdc}$, $P_{out} = 2.0\text{ W}$, $f = 136\text{ MHz}$)	G_{PE}	9.0	40.5	—	dB
Common Emitter Amplifier Power Gain ($V_{CC} = 27\text{ Vdc}$, $P_{out} = 8.0\text{ W}$, $f = 136\text{ MHz}$)	G_{PE}	13.0	14.9	—	dB
Collector Efficiency ($V_{CC} = 27\text{ Vdc}$, $P_{out} = 8.0\text{ W}$, $f = 136\text{ MHz}$)	η	50	60	—	%
Load Mismatch ($V_{CC} = 27\text{ Vdc}$, $P_{out} = 8.0\text{ W (peak)}$, $f = 136\text{ MHz}$. Drive modulated with 1.0 kHz square wave, 50% duty cycle. Load VSWR $\geq 20:1$, all phase angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 136 MHz TEST CIRCUIT



C1 — Arco 404 8–60 pF
 C2, C5 — 40 pF UNELCO
 C3 — 80 pF UNELCO
 C4, C11 — 0.1 μF Erie Redcap
 C6 — 25 pF UNELCO
 C7 — 5.0 pF UNELCO
 C8 — Arco 403 3–35 pF
 C9 — 510 pF Dipped Mica
 C10 — 680 pF Feedthru

L1 — 3 Turns #18 AWG, 1/8" ID
 L2, L3 — 4 Turns #18 AWG, 1/8" ID
 L4 — 0.33 μH Molded Choke
 L5 — 0.15 μH Molded Choke with Ferrite Bead
 L6 — 0.47 μH Molded Choke with Ferrite Bead
 L7 — VK-200-19/4B
 R1 — 100 Ω , 1.0 Watt

FIGURE 2 — POWER GAIN versus FREQUENCY

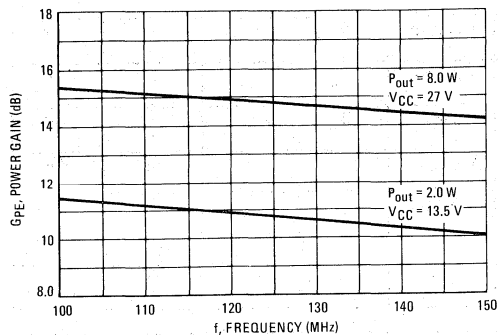
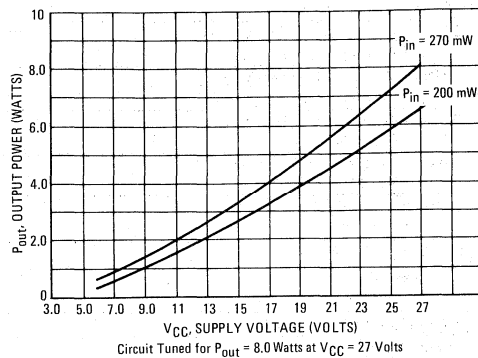
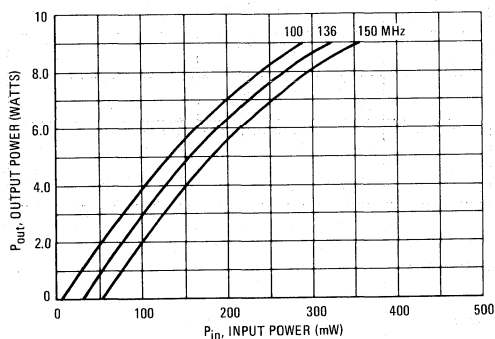
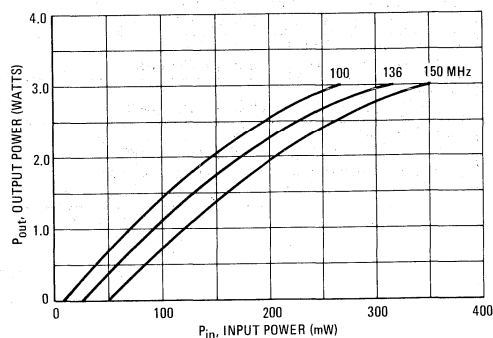
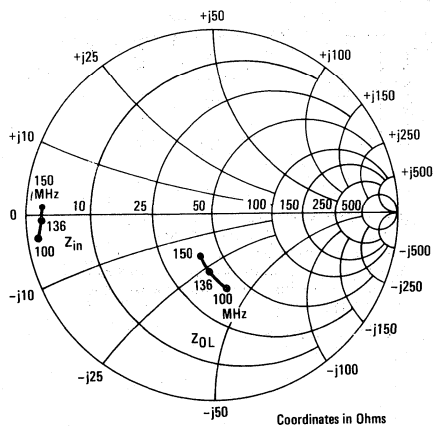
FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE
($f = 136$ MHz)FIGURE 4 — OUTPUT POWER versus INPUT POWER
($V_{CC} = 27$ V)FIGURE 5 — OUTPUT POWER versus INPUT POWER
($V_{CC} = 13.5$ V)

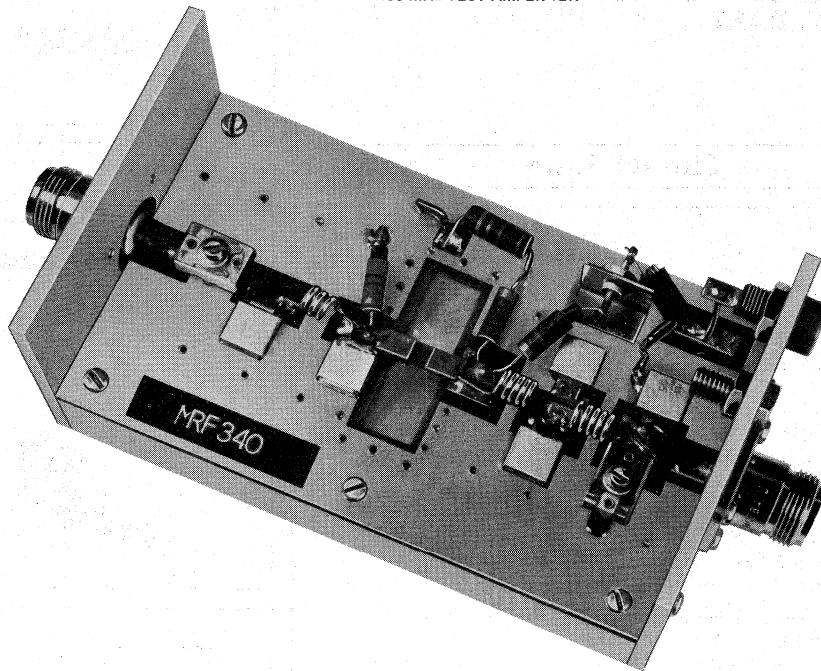
FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

 $V_{CC} = 27$ V $P_{out} = 8.0$ W

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
100	$3.40 - j1.70$	$42.6 - j31.8$
136	$4.00 - j0.57$	$39.2 - j26.4$
150	$3.95 + j0.66$	$38.3 - j17.0$

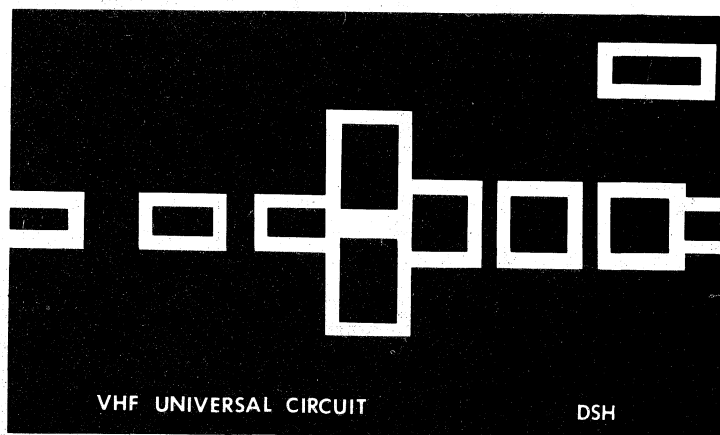
* Z_{OL} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 - 136 MHz TEST AMPLIFIER



2

FIGURE 8 - PRINTED CIRCUIT BOARD LAYOUT - 136 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for use in VHF amplifiers with amplitude modulation and other communications equipment operating to 150 MHz.

- Low Cost Common Emitter TO-220 Package
- Specified 27 V, 136 MHz Performance:
Output Power = 24 W
Power Gain = 11 dB Min
Efficiency = 50% Min
- 20:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage
- Other Devices in the Series:
MRF340 8.0 W
MRF344 60 W

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.2	Adc
Peak		3.0	
Total Device Dissipation — $T_C = 25^\circ\text{C}$ (1)	P_D	55	Watts
Derate above 25°C		310	mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.2	$^\circ\text{C}/\text{W}$

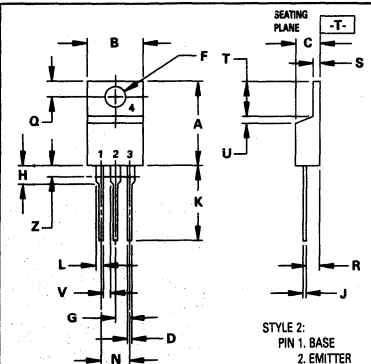
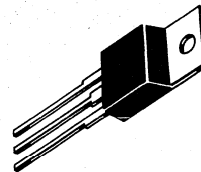
- These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

MRF342

24 W 100–150 MHz

RF POWER TRANSISTOR

NPN SILICON



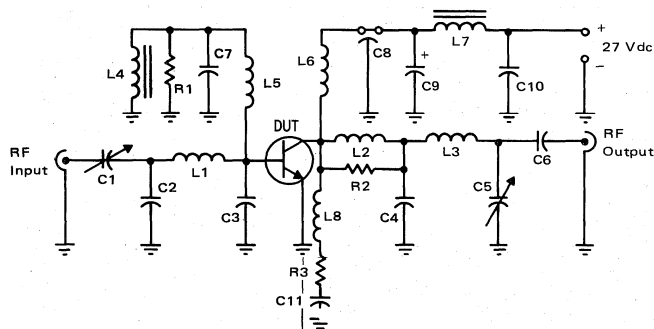
- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 - CONTROLLING DIMENSION: INCH.
 - DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.60	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.86	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.38	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 27\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 27\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	20	30	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 13.5\text{ Vdc}$, $P_{out} = 6.0\text{ W}$, $f = 136\text{ MHz}$)	G_{pE}	10	11.5	—	dB
Common-Emitter Amplifier Power Gain ($V_{CC} = 27\text{ Vdc}$, $P_{out} = 24\text{ W}$, $f = 136\text{ MHz}$)	G_{pE}	11	12.3	—	dB
Collector Efficiency ($V_{CC} = 27\text{ Vdc}$, $P_{out} = 24\text{ W}$, $f = 136\text{ MHz}$)	η	50	60	—	%
Load Mismatch ($V_{CC} = 27\text{ Vdc}$, $P_{out} = 24\text{ W (peak)}$, $f = 136\text{ MHz}$ Drive modulated with 1.0 kHz square wave, 50% duty cycle. Load VSWR $\geq 20:1$, all phase angles)	ψ	No Degradation in Power Output			



C1 — Arco 404
 C2 — 25 pF UNELCO
 C3, C7 — 200 pF UNELCO
 C4 — 40 pF UNELCO
 C5 — Arco 462
 C6 — 510 pF Dipped Mica
 C8 — 680 pF Feedthru
 C9 — 1.0 μF 50 V Tantalum
 C10, C11 — 0.1 μF Erie Redcap 100 V

L1, L2 — 3 Turns #18 AWG, 1/8" ID
 L3 — 5 Turns #18 AWG, 1/8" ID
 L4, L7 — VK-200-19/48
 L5 — 0.15 μH Molded Choke
 L6 — 0.22 μH Molded Choke
 L8 — 0.47 μH Molded Choke
 R1 — 22 Ω , 2 Watt
 R2 — 910 Ω , 1 Watt
 R3 — 12 Ω , 1 Watt

Figure 1. 136 MHz Test Circuit

FIGURE 2 — POWER GAIN versus FREQUENCY

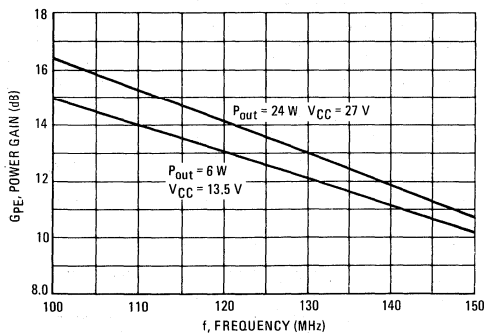
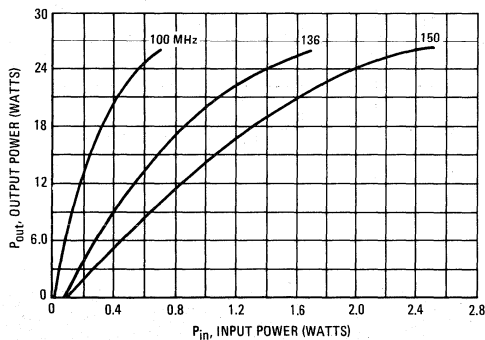
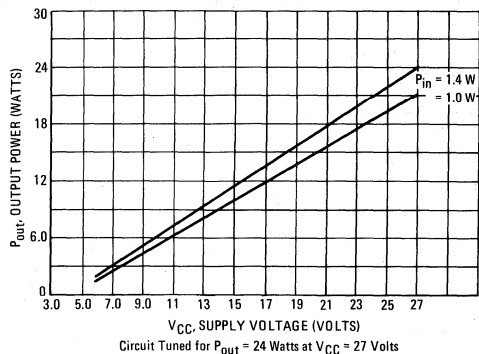
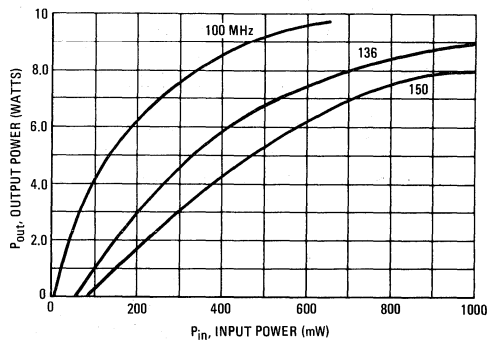
FIGURE 4 — OUTPUT POWER versus INPUT POWER
($V_{CC} = 27$ V)FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE
($f = 136$ MHz)FIGURE 5 — OUTPUT POWER versus INPUT POWER
($V_{CC} = 13.5$ V)

FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

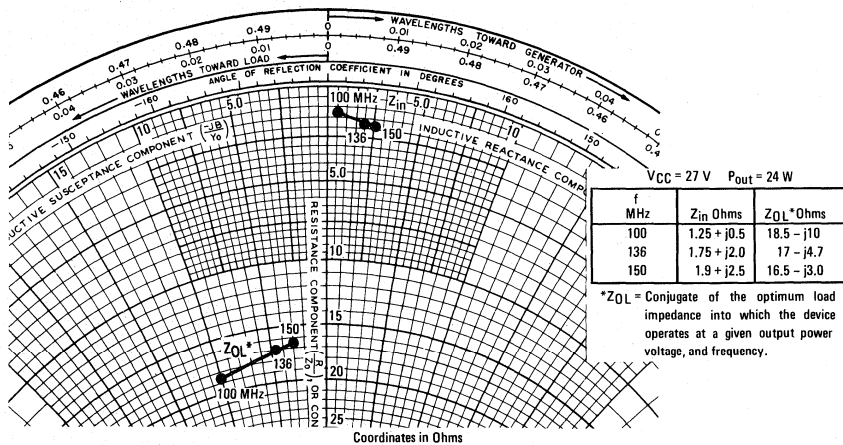
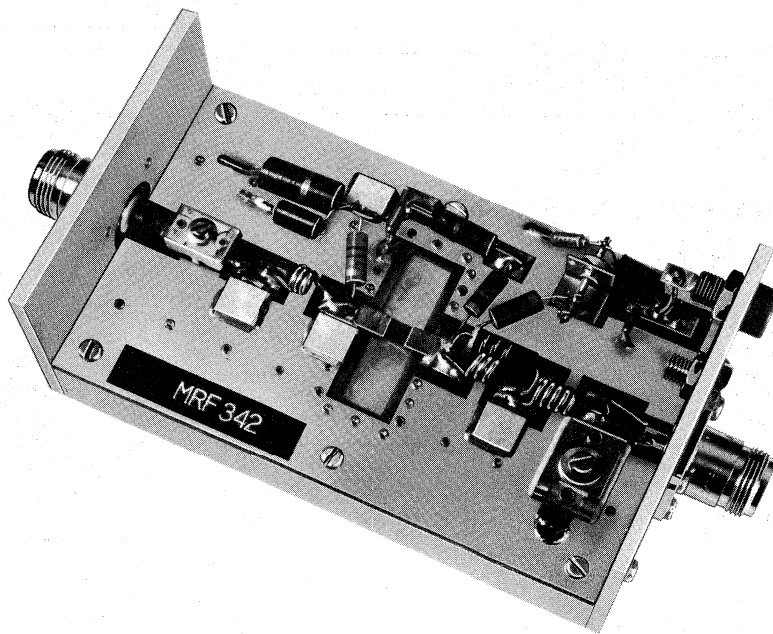
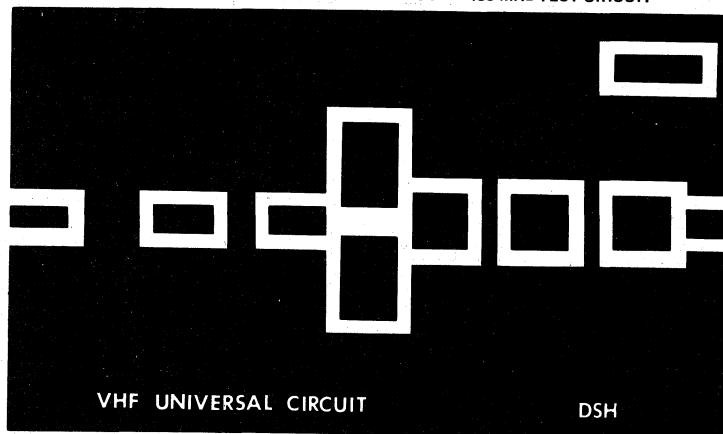


FIGURE 7 — 136 MHz TEST AMPLIFIER



2

FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 136 MHz TEST CIRCUIT



Note: The Printed Circuit Board shown is 75% of the original.

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for use in VHF amplifiers with amplitude modulation and other communications equipment operating to 150 MHz.

- Low Cost Common Emitter TO-220AB Package
- Specified 27 V, 136 MHz Performance:
 - Output Power = 60 W
 - Power Gain = 6.0 dB Min
 - Efficiency = 50% Min
- 20:1 VSWR Load Mismatch Capability at Rated Peak Output Power and Supply Voltage
- Other Devices in the Series:
 - MRF340 8 W
 - MRF342 24 W

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	5.0	Adc
Peak		6.0	
Total Device Dissipation — $T_C = 25^\circ\text{C}$ (1)	P_D	87.5	Watts
Derate above 25°C		0.5	mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	$^\circ\text{C}/\text{W}$

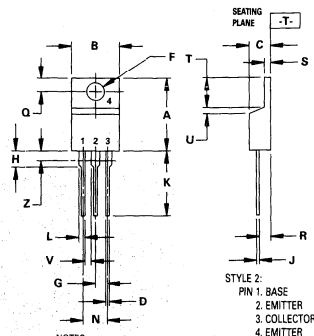
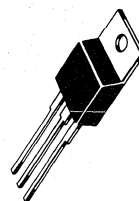
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

MRF344

60 W 100–150 MHz

RF POWER TRANSISTOR

NPN SILICON



NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.6M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

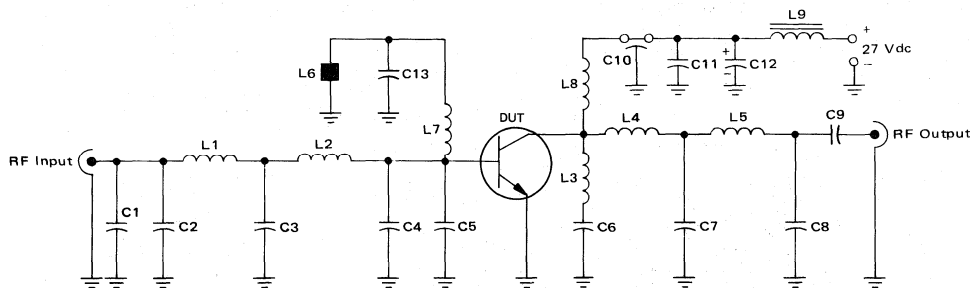
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.95	0.014	0.037
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
 TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^{\circ}\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 27 \text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	10	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 27 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	130	200	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 13.5 \text{ Vdc}$, $P_{out} = 15 \text{ W}$, $f = 136 \text{ MHz}$)	G_{PE}	4.0	4.5	—	dB
Common Emitter Amplifier Power Gain ($V_{CC} = 27 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 136 \text{ MHz}$)	G_{PE}	6.0	6.7	—	dB
Collector Efficiency ($V_{CC} = 27 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 136 \text{ MHz}$)	η	50	60	—	%
Load Mismatch ($V_{CC} = 27 \text{ Vdc}$, $P_{out} = 60 \text{ W}$ (peak), $f = 136 \text{ MHz}$. Drive modulated with 1.0 kHz square wave, 50% duty cycle. Load VSWR $\geq 20:1$, all phase angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 136 MHz TEST CIRCUIT



C1, C2 — 10 pF UNELCO
 C3, C8 — 25 pF UNELCO
 C4, C5, C7 — 100 pF UNELCO
 C6, C11 — 0.1 μF Erie Redcap
 C9 — 1000 pF UNELCO
 C10 — 1000 pF UNELCO Feedthru
 C12 — 1.0 μF 50 V Tantalum
 C13 — 200 pF UNELCO

L1 — 3/4" of #20 AWG
 L2 — 1/2" of #20 AWG
 L3 — 2 Turns, 1/8" ID #20 AWG
 L4 — Copper Strap 15 mil Thick
 3/16" X 1/2" L
 L5 — 2 Turns #20 AWG 1/4" ID
 L6 — Ferrite Bead on Lead of L7
 L7, L8 — 0.15 μH Molded Choke
 L9 — VK-200-19/4B

Input/Output Connectors Type N

FIGURE 2 – POWER GAIN versus FREQUENCY

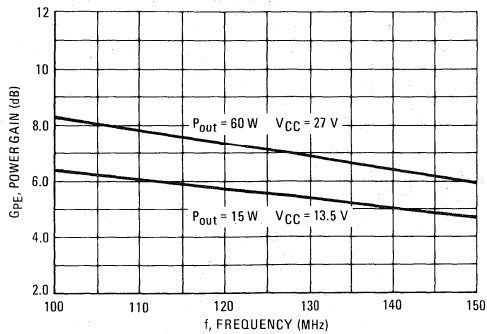
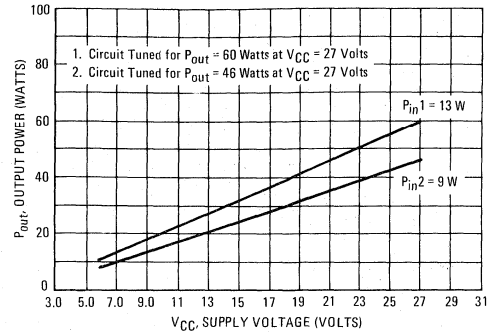
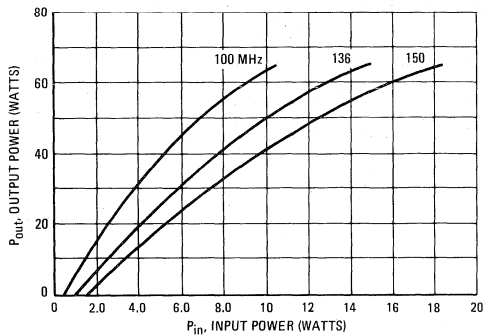
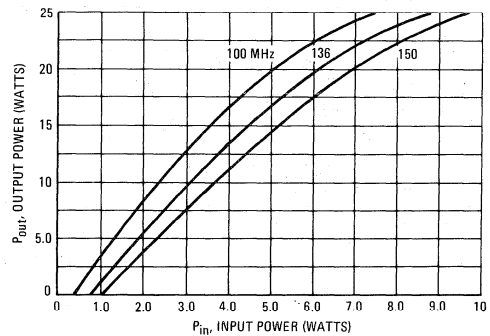
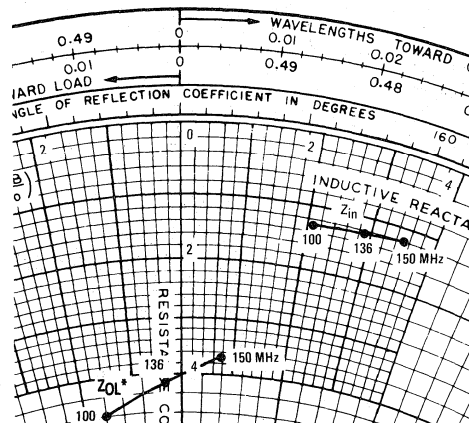
FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE
(f = 136 MHz)FIGURE 4 – OUTPUT POWER versus INPUT POWER
(VCC = 27 V)FIGURE 5 – OUTPUT POWER versus INPUT POWER
(VCC = 13.5 V)

FIGURE 6 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

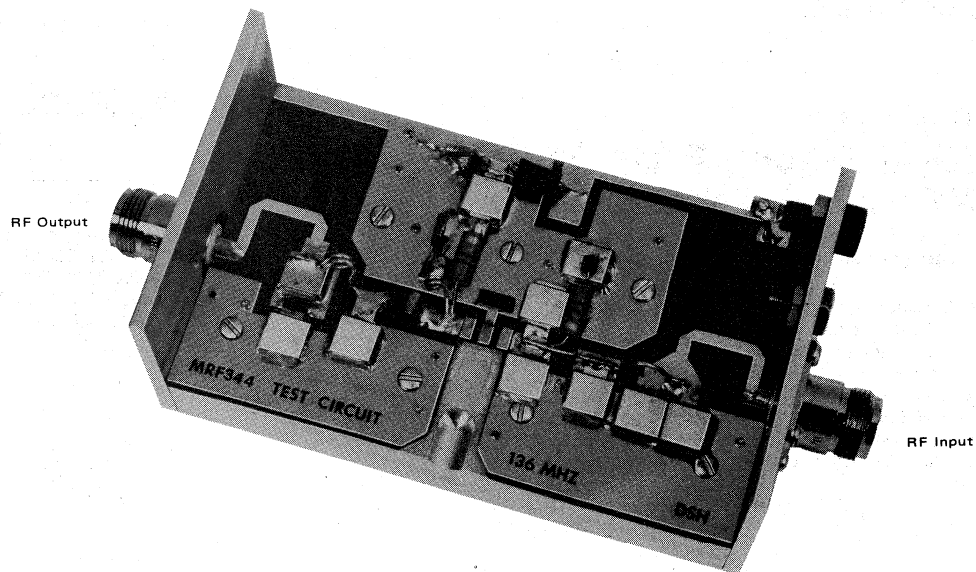


VCC = 27 V Pout = 60 W

f MHz	Z _{in} Ohms	Z _{OL} * Ohms
100	1.33 + j2.1	4.8 - j1.6
136	1.25 + j2.86	4.2 - j0.32
150	1.2 + j3.5	3.7 + j0.8

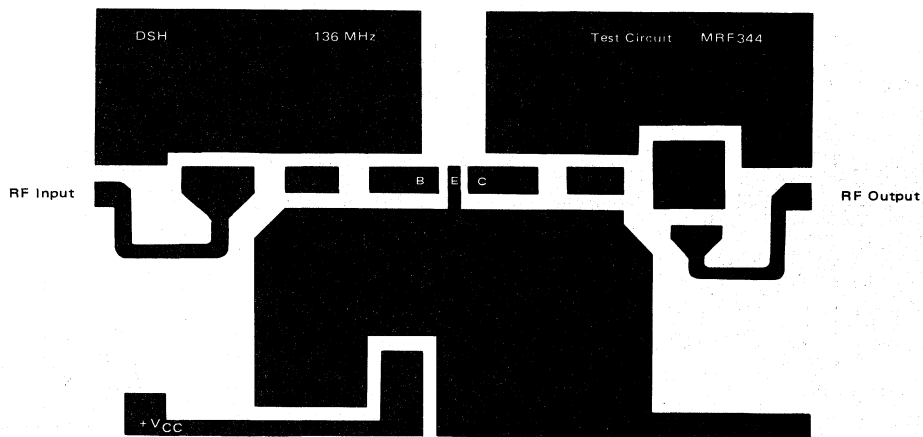
*Z_{OL} = Conjugate of the optimum load impedance into which the device operates at a given output power voltage, and frequency.

FIGURE 7 – 136 MHz TEST AMPLIFIER



2

FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 136 MHz TEST CIRCUIT



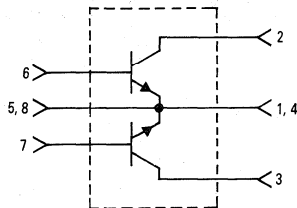
NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

NPN Silicon Push-Pull RF Power Transistor

... designed primarily for wideband large-signal output and driver amplifier stages in the 30–500 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
 Output Power = 60 Watts
 Typical Gain = 9.5 dB
 Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch



The MRF390 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

PUSH-PULL TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	7	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	140 0.80	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$

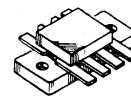
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	$^\circ\text{C}/\text{W}$

(1) This device is designed for RF operation. The total dissipation rating applies only when the device is operated as an RF push-pull amplifier.

MRF390

**60 WATTS, 30–500 MHz
 CONTROLLED "Q"
 BROADBAND PUSH-PULL
 RF POWER TRANSISTOR
 NPN SILICON**



CASE 744-02

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 3\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	3	mA

ON CHARACTERISTICS (NOTE 1)

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS (NOTE 1)

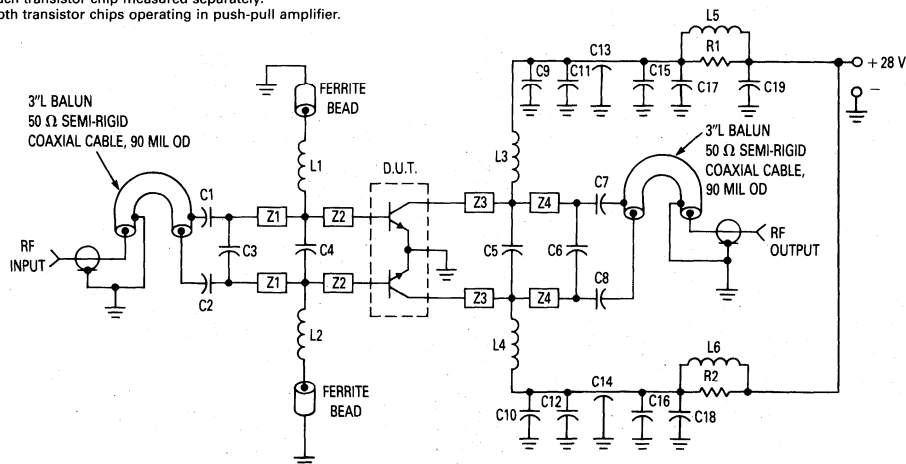
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	37	50	pF
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FUNCTIONAL TEST (NOTE 2 — See Figure 1)

Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$)	G_{pe}	7.5	9.5	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$)	η	50	55	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 60\text{ W}$, $f = 400\text{ MHz}$, $VSWR = 30:1$, all phase angles)	ψ	No Degradation in Output Power			

NOTES:

- Each transistor chip measured separately.
- Both transistor chips operating in push-pull amplifier.

**Figure 1. 400 MHz Test Circuit**

C1, C2 — 240 pF, 100 Mil Chip
 C3 — 12 pF, 100 Mil Chip
 C5 — 20 pF, 100 Mil Chip
 C4, C6 — 18 pF, 100 Mil Chip
 C7, C8 — 270 pF, 100 Mil Chip
 C9, C10, C11, C12 — 470 pF, 100 Mil Chip
 C13, C14 — 680 pF Feedthru Capacitor
 C15, C16, C19 — 0.1 μF Disc Ceramic
 C17, C18 — 1 μF , 50 V Tantalum Capacitor
 R1, R2 — 910 k Ω , 2 W Carbon Res.

L1, L2 — 10 μH RF Choke With Ferrite Bead
 L3, L4 — 5 Turns #20 AWG, 1/4\" ID
 L5, L6 — 15 Turns #18 AWG Enameled, 0.35\" ID Closewound Around
 R1, R2 Respectively
 Z1 — Microstrip Line 850 Mils L x 130 Mils W
 Z2, Z3 — Microstrip Line 250 Mils L x 130 Mils W
 Z4 — Microstrip Line 830 Mils L x 130 Mils W
 Board Material — 0.0625\" Teflon Fiberglass $\epsilon_r = 2.5 \pm 0.05$,
 1 oz. cu. clad, Double Sided

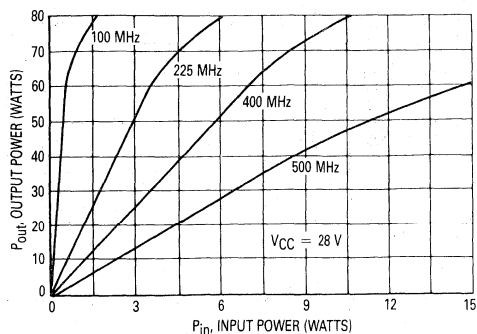


Figure 2. Output Power versus Input Power/Frequency

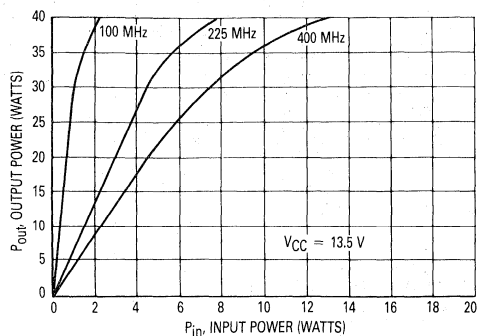


Figure 3. Output Power versus Input Power/Frequency

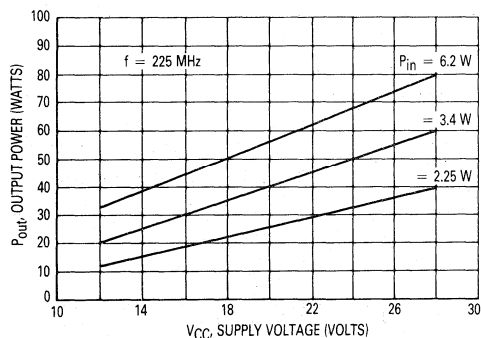


Figure 4. Output Power versus Supply Voltage — 225 MHz

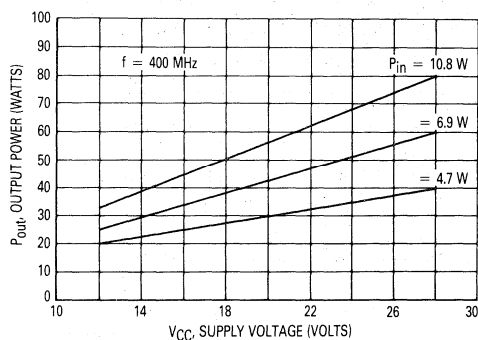


Figure 5. Output Power versus Supply Voltage — 400 MHz

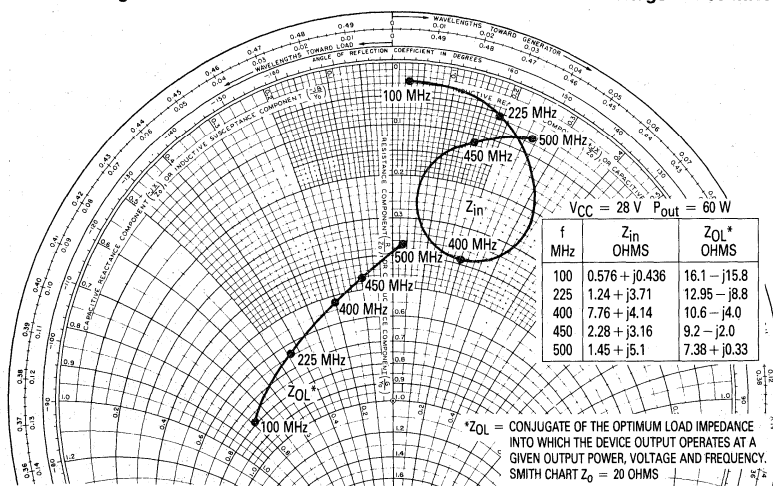
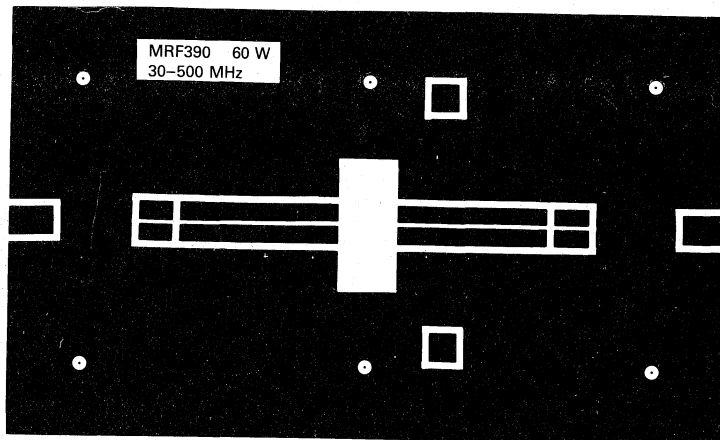


Figure 6. Series Equivalent Input/Output Impedances



NOTE: The Printed Circuit Board shown is 75% of the original.

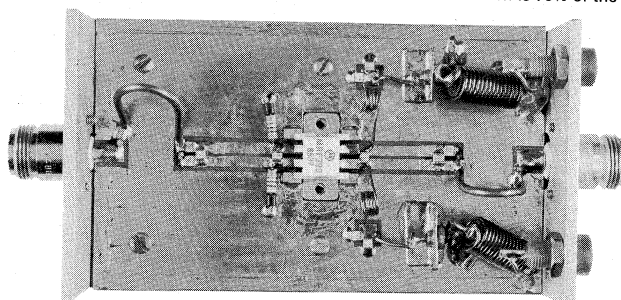


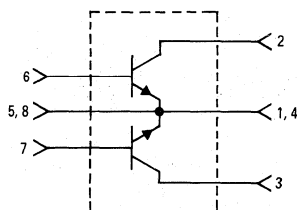
Figure 7. 400 MHz Test Circuit and Photomaster

The RF Line

NPN Silicon Push-Pull RF Power Transistor

... designed primarily for wideband large-signal output and driver amplifier stages in the 30–500 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
Output Power = 125 W
Typical Gain = 10 dB
Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch.



The MRF392 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

PUSH-PULL TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	30	Vdc
Collector-Base Voltage	V_{CB0}	60	Vdc
Emitter-Base Voltage	V_{EB0}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	270 1.54	Watts $W/^\circ\text{C}$
Storage Temperature Range	T_{stg}	– 65 to + 150	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$

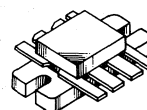
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF push-pull amplifier.

MRF392

**125 WATTS, 30–500 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON**



CASE 744A-01

MRF392

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (NOTE 1)

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5	mAdc

ON CHARACTERISTICS (NOTE 1)

DC Current Gain ($I_C = 1\text{ Adc}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS (NOTE 1)

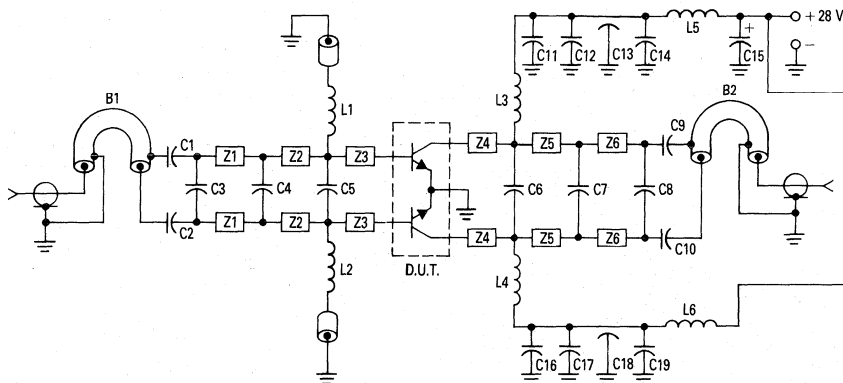
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	75	115	pF
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FUNCTIONAL TEST (NOTE 2 — See Figure 1)

Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 125\text{ W}$, $f = 400\text{ MHz}$)	G_{pe}	8	10	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 125\text{ W}$, $f = 400\text{ MHz}$)	η	50	55	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 125\text{ W}$, $f = 400\text{ MHz}$ VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES:

- Each transistor chip measured separately.
- Both transistor chips operating in push-pull amplifier.



C1, C2 — 240 pF, 100 Mil Chip Cap (ATC) or Equivalent
 C3 — 3.6 pF, 100 Mil Chip Cap (ATC) or Equivalent
 C4, C8 — 8.2 pF, 100 Mil Chip Cap (ATC) or Equivalent
 C5, C6 — 20 pF, 100 Mil Chip Cap (ATC) or Equivalent
 C7 — 18 pF, 100 Mil Chip Cap (ATC) or Equivalent
 C9, C10 — 270 pF, 100 Mil Chip Cap (ATC) or Equivalent
 C11, C12, C16, C17 — 470 pF 100 Mil Chip Cap (ATC) or Equivalent
 C13, C18 — 680 pF Feedthru
 C14, C19 — 0.1 μF Erie Redcap or Equivalent
 C15 — 20 μF , 50 V

L1, L2 — 0.15 μH Molded Choke With Ferrite Bead
 L3, L4 — 2-1/2 Turns #20 AWG, 0.200 ID
 L5, L6 — 3-1/2 Turns #18 AWG, 0.200 ID

B1 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2" L
 B2 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2" L

Z1 — Microstrip Line 270 Mil L x 125 Mil W
 Z2 — Microstrip Line 375 Mil L x 125 Mil W
 Z3 — Microstrip Line 280 Mil L x 125 Mil W
 Z4 — Microstrip Line 300 Mil L x 125 Mil W
 Z5 — Microstrip Line 350 Mil L x 125 Mil W
 Z6 — Microstrip Line 365 Mil L x 125 Mil W

Board Material — 0.0625" Teflon Fiberglass $\epsilon_r = 2.5 \pm 0.05$ 1 oz. Cu.
 CLAD, Double Sided

Figure 1. 400 MHz Test Fixture

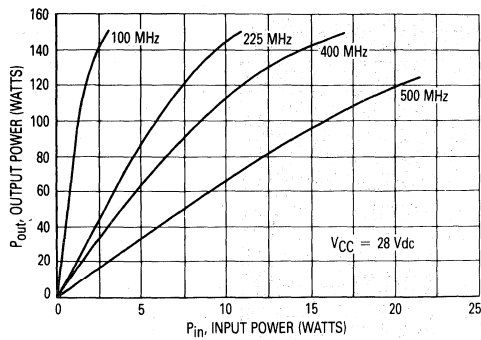


Figure 2. Output Power versus Input Power

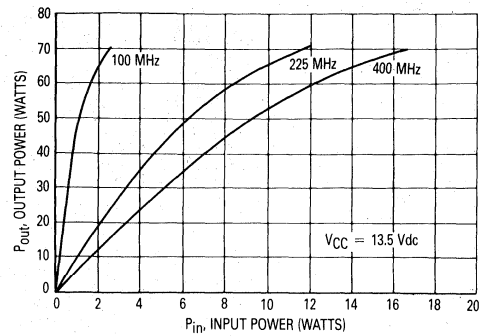


Figure 3. Output Power versus Input Power

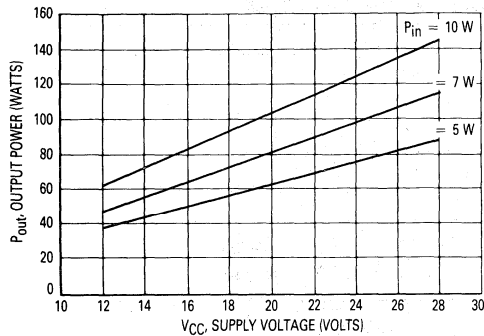


Figure 4. Output Power versus Supply Voltage — 225 MHz

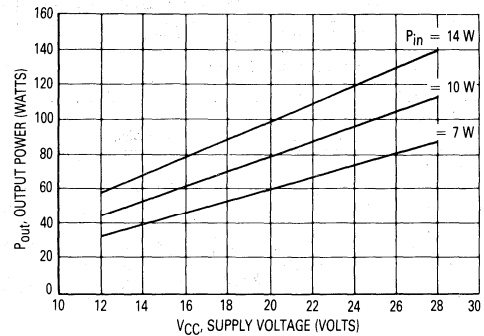


Figure 5. Output Power versus Supply Voltage — 400 MHz

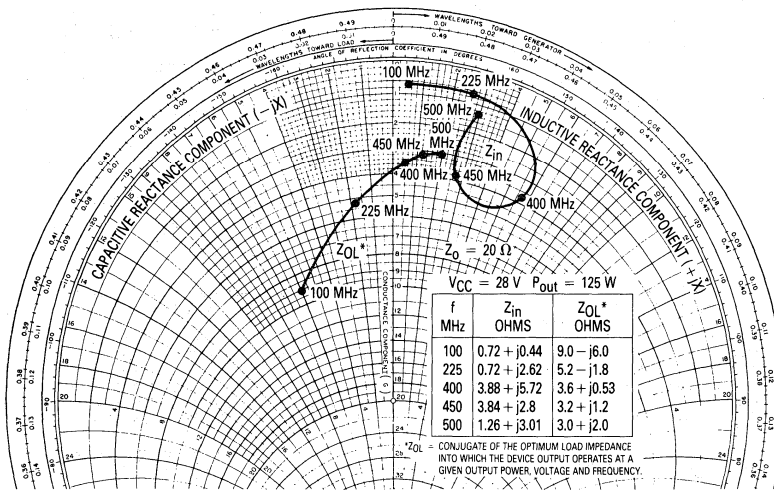
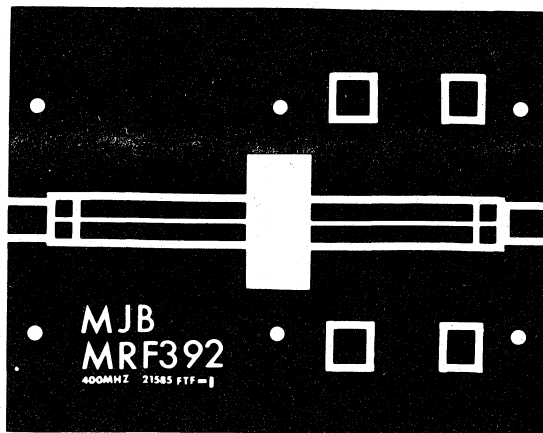


Figure 6. Series Equivalent Input/Output Impedance



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 7. Test Circuit Photomaster

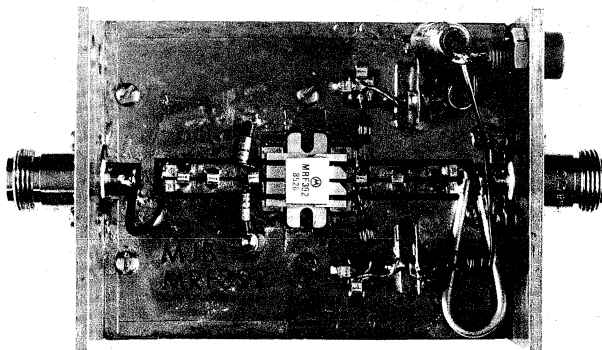


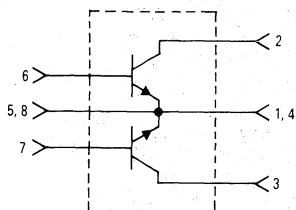
Figure 8. 400 MHz Test Circuit

The RF Line

NPN Silicon Push-Pull RF Power Transistor

... designed primarily for wideband large-signal output and driver amplifier stages in the 30–500 MHz frequency range.

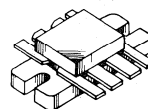
- Specified 28 Volt, 500 MHz Characteristics —
 Output Power = 100 W
 Typical Gain = 9.5 dB (Class AB); 8.5 dB (Class C)
 Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch



The MRF393 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

MRF393

**100 WATTS, 30–500 MHz
 CONTROLLED "Q"
 BROADBAND PUSH-PULL
 RF POWER TRANSISTOR
 NPN SILICON**



CASE 744A-01

PUSH-PULL TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB0}	60	Vdc
Emitter-Base Voltage	V_{EB0}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	270 1.54	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +150	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF push-pull amplifier.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5	mAdc

ON CHARACTERISTICS (NOTE 1)

DC Current Gain ($I_C = 1\text{ Adc}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS (NOTE 1)

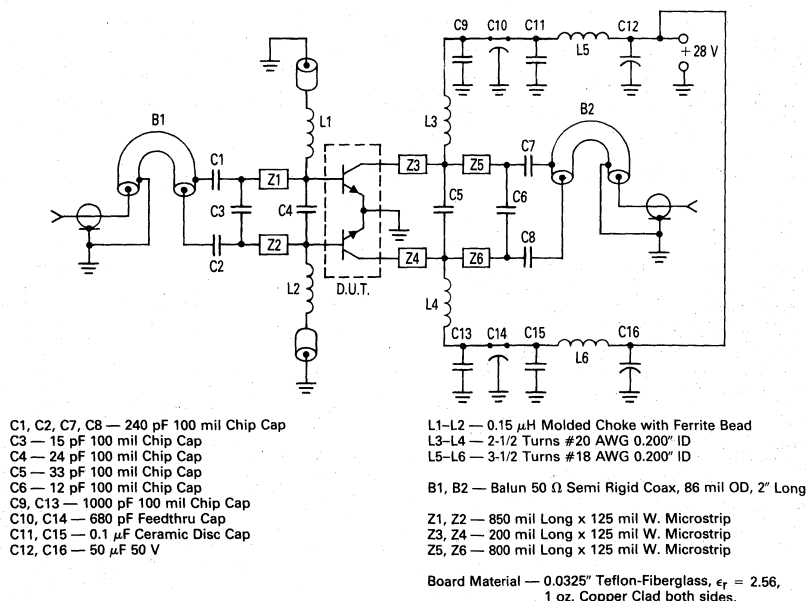
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	75	115	pF
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FUNCTIONAL TEST (NOTE 2 — See Figure 1)

Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 100\text{ W}$, $f = 500\text{ MHz}$)	G_{pe}	7.5	8.5	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 100\text{ W}$, $f = 500\text{ MHz}$)	η	50	55	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 100\text{ W}$, $f = 500\text{ MHz}$ $VSWR = 30:1$, all phase angles)	ψ	No Degradation in Output Power			

NOTES:

- Each transistor chip measured separately.
- Both transistor chips operating in push-pull amplifier.

**Figure 1. 500 MHz Test Fixture**

OUTPUT POWER versus INPUT POWER
CLASS C

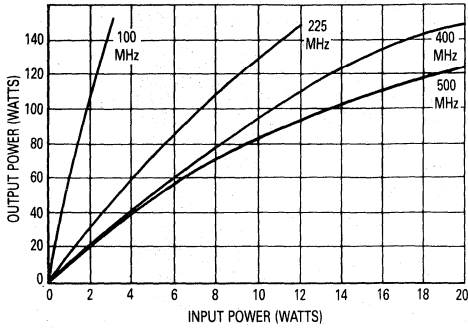


Figure 2. $V_{CC} = 28\text{ V}$

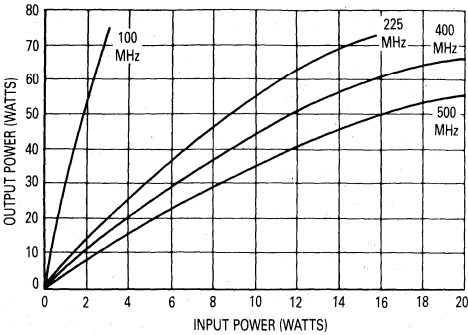


Figure 3. $V_{CC} = 13.5\text{ V}$

OUTPUT POWER versus SUPPLY VOLTAGE
CLASS C

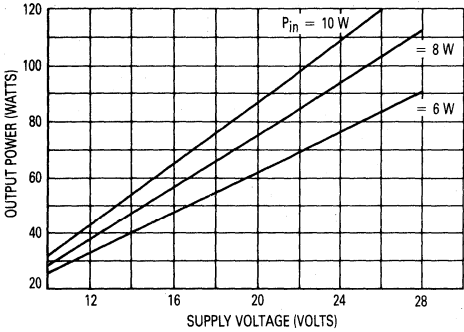


Figure 4. $f = 225\text{ MHz}$

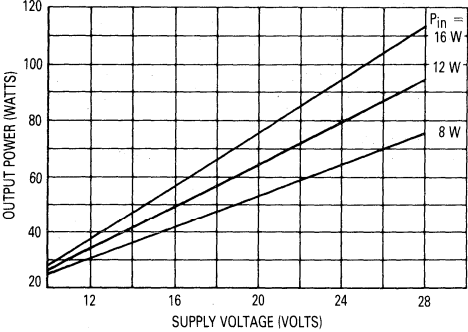


Figure 5. $f = 500\text{ MHz}$

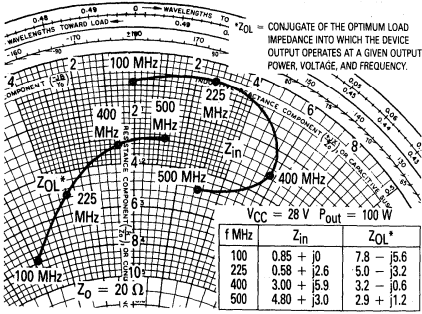


Figure 6. Series Equivalent Input/Output Impedance

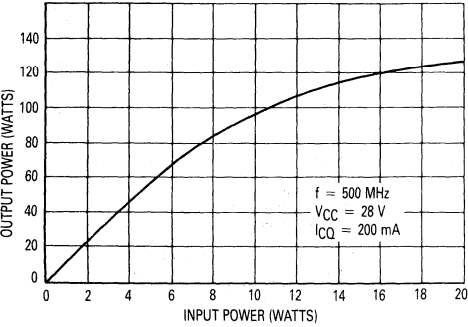
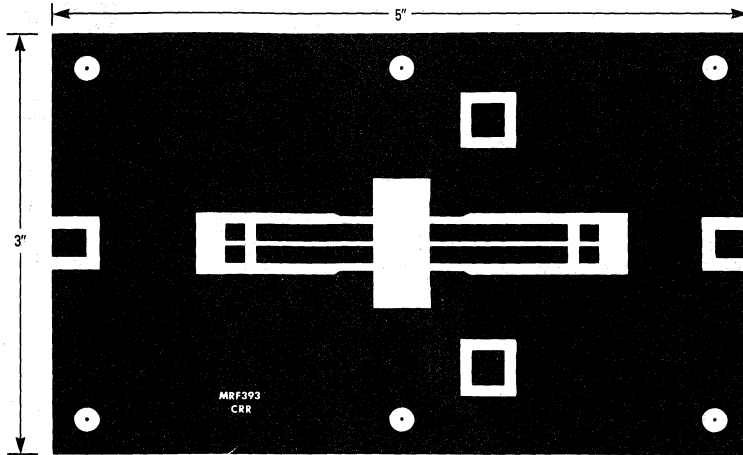


Figure 7. Class AB Output Power versus Input Power



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 8. Test Circuit Photomaster

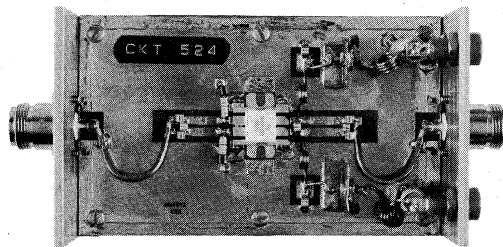


Figure 9. 500 MHz Test Circuit

MRF401

The RF Line

NPN SILICON RF POWER TRANSISTORS

...designed primarily for applications as a high-power linear amplifier from 2.0 to 75 MHz.

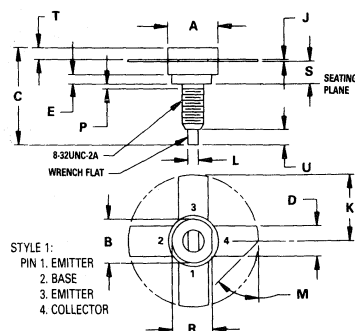
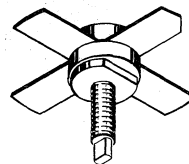
- Specified 28 Volt, 30 MHz Characteristics —
Output Power = 25 W (PEP)
Minimum Gain = 13 dB
Efficiency = 40%
- Intermodulation Distortion at 25 W (PEP)
IMD = -32 dB (Max)
- Isothermal-Resistor Design Results in Rugged Device

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	30	Vdc
Emitter-Base Voltage	V_{EB0}	4.0	Vdc
Collector Current — Continuous	I_C	3.3	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	50 0.286	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as Class B or C RF amplifiers.

25 W PEP — 30 MHz
RF POWER
TRANSISTOR
NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM	—	45° NOM	—
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	10	20	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	65	85	pF
FUNCTIONAL TEST (Figure 1)					
Common-Emitter Amplifier Power Gain ($P_{out} = 25 \text{ Watts PEP}$, $I_C (\text{max}) = 1.12 \text{ Adc}$, $V_{CC} = 28 \text{ Vdc}$, $f = 30 \text{ MHz}$)	G_{PE}	13	—	—	dB
Collector Efficiency ($P_{out} = 25 \text{ Watts PEP}$, $I_C (\text{max}) = 1.12 \text{ Adc}$, $V_{CC} = 28 \text{ Vdc}$, $f = 30 \text{ MHz}$)	η	40	—	—	%
Intermodulation Distortion ($P_{out} = 25 \text{ Watts PEP}$, $I_C = 1.12 \text{ Adc}$, $V_{CC} = 28 \text{ Vdc}$, $f_1 = 30 \text{ MHz}$, $f_2 = 30.001 \text{ MHz}$)	IMD	—	—	-32	dB

FIGURE 1 - 30 MHz LINEAR TEST CIRCUIT

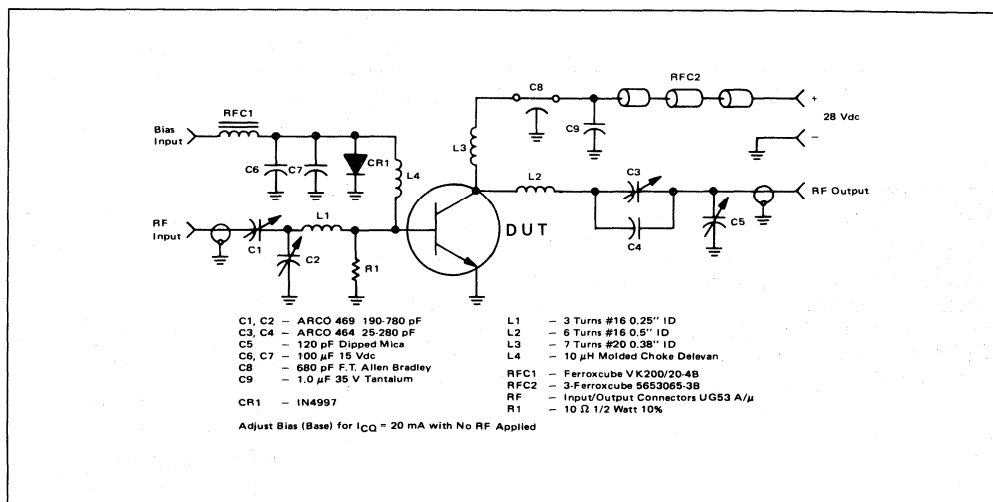


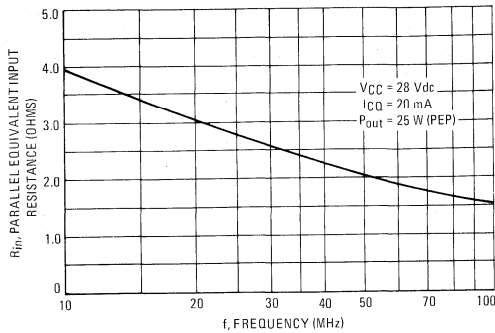
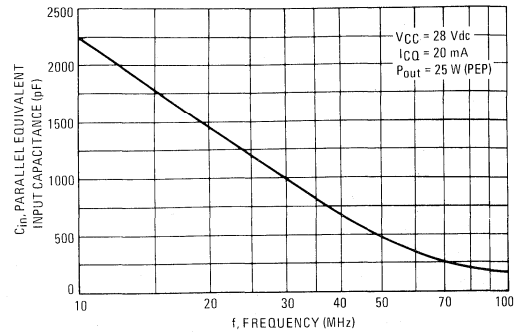
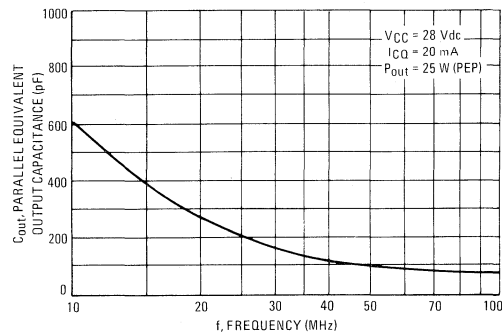
FIGURE 2 – PARALLEL EQUIVALENT INPUT RESISTANCE
versus FREQUENCYFIGURE 3 – PARALLEL EQUIVALENT INPUT
CAPACITANCE versus FREQUENCYFIGURE 4 – PARALLEL EQUIVALENT OUTPUT
CAPACITANCE versus FREQUENCY

FIGURE 5 – POWER GAIN versus FREQUENCY

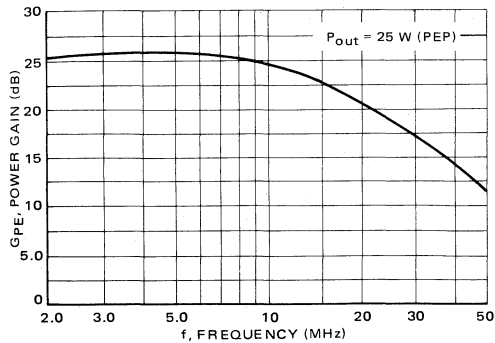
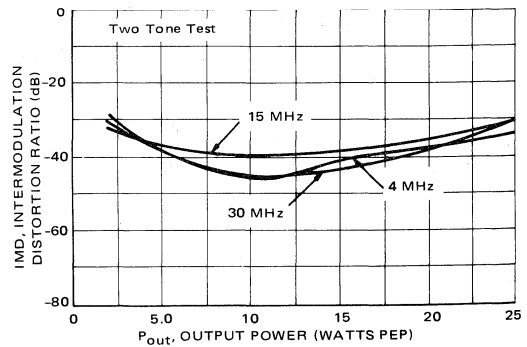


FIGURE 6 – IMD versus POWER OUTPUT



MRF406

The RF Line

NPN SILICON RF POWER TRANSISTOR

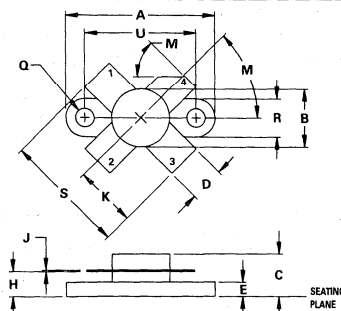
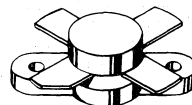
... designed primarily for application as a power linear amplifier from 2.0 to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
Output Power = 20 W(PEP)
Minimum Gain = 12 dB
Efficiency = 45%
- Intermodulation Distortion @ 20 W(PEP) —
IMD = -30 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with
30:1 VSWR

20 W(PEP) — 30 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER
ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.68	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Withstand Current ($t = 5.0$ s)	—	12	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	80 0.46	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 12.5\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	35	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	150	200	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 20\text{ W(PEP)}$, $I_{C(max)} = 1.75\text{ Adc}$, $I_{CQ} = 25\text{ mAdc}$, $f = 30, 30.001\text{ MHz}$)	G_{pE}	12	15	—	dB
Power Output ($V_{CE} = 12.5\text{ Vdc}$, $f = 30\text{ MHz}$)	P_{out}	20	—	—	Watts(PEP)
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 20\text{ W(PEP)}$, $I_{C(max)} = 1.75\text{ Adc}$, $I_{CQ} = 25\text{ mAdc}$, $f = 30, 30.001\text{ MHz}$)	η	45	—	—	%
Intermodulation Distortion ($V_{CE} = 12.5\text{ Vdc}$, $P_{out} = 20\text{ W(PEP)}$, $I_{C(max)} = 1.75\text{ Adc}$, $I_{CQ} = 25\text{ Adc}$, $f = 30, 30.001\text{ MHz}$)	IMD	-30	-35	—	dB
Load Mismatch ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 20\text{ W(PEP)}$, $I_C = 1.75\text{ Adc}$, $I_{CQ} = 25\text{ mAdc}$, $f = 30, 30.001\text{ MHz}$)	—	> 30:1 All Phase Angles			—

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC

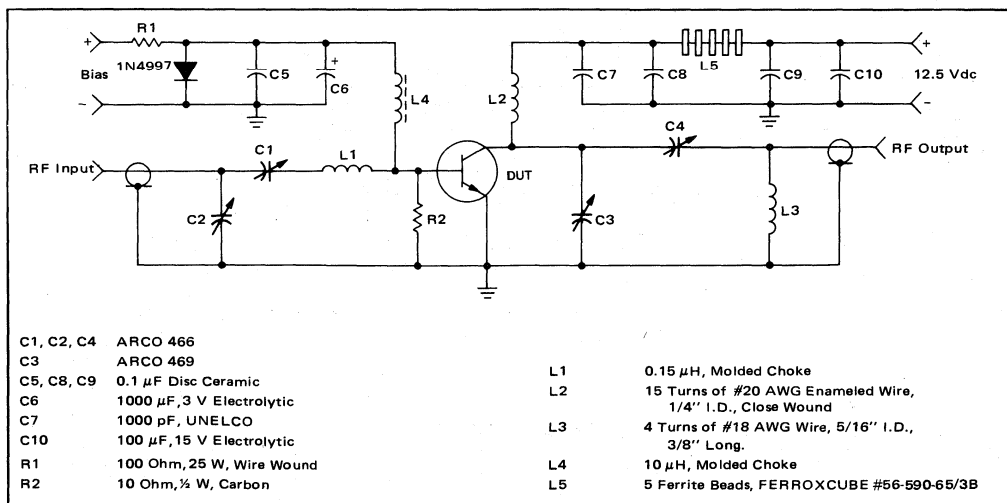


FIGURE 2 – OUTPUT POWER versus INPUT POWER

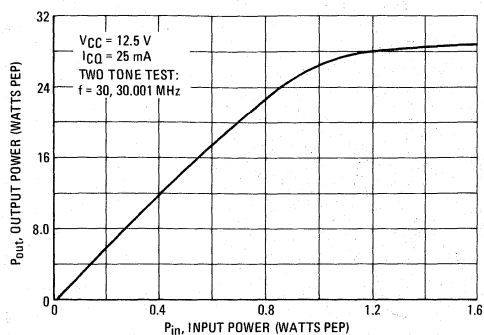


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

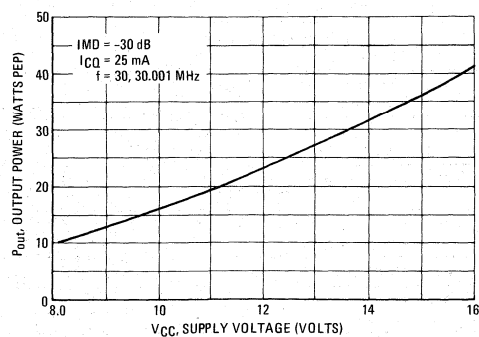


FIGURE 4 – POWER GAIN versus FREQUENCY

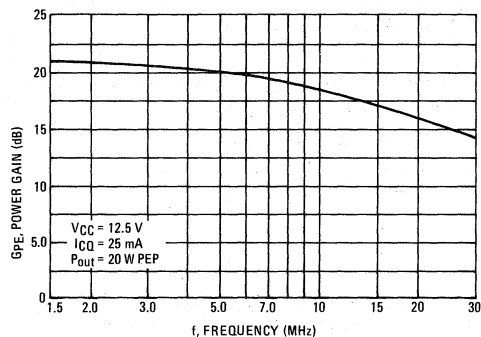


FIGURE 5 – INTERMODULATION DISTORTION versus OUTPUT POWER

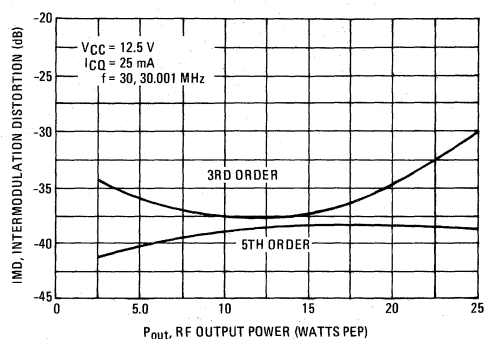


FIGURE 6 – DC SAFE OPERATING AREA

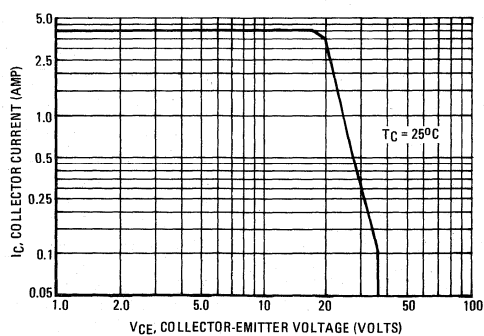


FIGURE 7 – SERIES EQUIVALENT IMPEDANCE

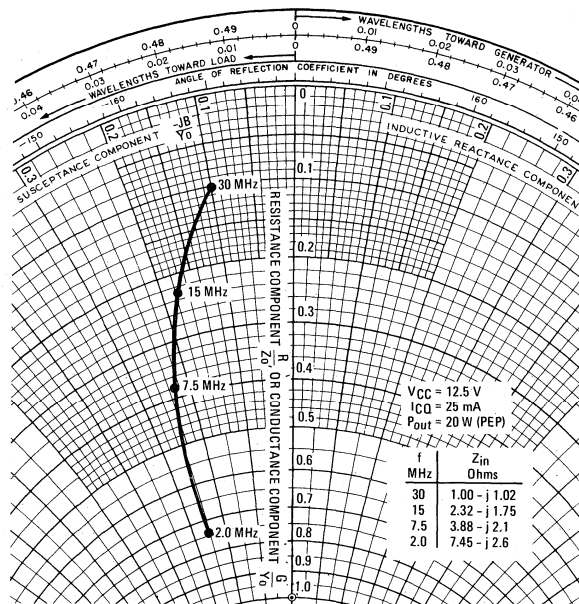


FIGURE 8 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

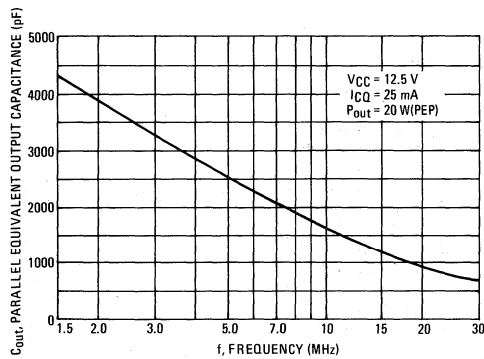
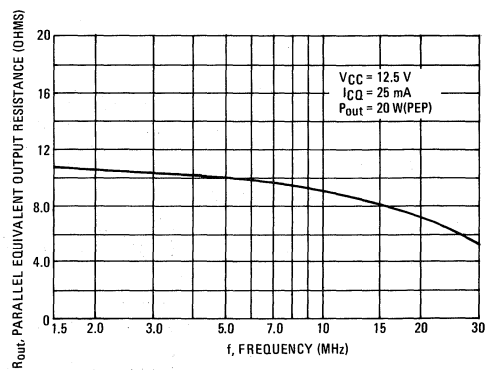


FIGURE 9 – PARALLEL EQUIVALENT OUTPUT RESISTANCE versus FREQUENCY



The RF Line

NPN Silicon

RF Power Transistors

... designed for high gain driver and output linear amplifier stages in 1.5 to 30 MHz HF/SSB equipment.

- Specified 28 Volt, 30 MHz Characteristics —
 Output Power = 10 W
 Minimum Gain = 13 dB
 Efficiency = 40%
- Intermodulation Distortion @ 10 W (PEP) —
 IMD = -30 dB (Max)
- 100% Tested for Load Mismatch at All Phase Angles With 30:1 VSWR
- Direct Replacement for 2N6370

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE}	35	Vdc
Collector-Base Voltage	V_{CB}	65	Vdc
Emitter-Base Voltage	V_{EB}	4	Vdc
Collector Current — Continuous	I_C	1.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	40 0.23	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.35	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28 \text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1 \text{ Adc}$, $V_{CE} = 5 \text{ Vdc}$)	h_{FE}	10	35	100	—
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DYNAMIC CHARACTERISTICS

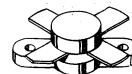
Output Capacitance ($V_{CB} = 28 \text{ Vdc}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	85	100	pF
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(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

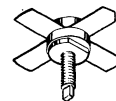
(continued)

MRF410
MRF410A

10 W-30 MHz
RF POWER
TRANSISTORS
NPN SILICON



MRF410
CASE 211-07



MRF410A
CASE 145A-09

MRF410, MRF410A

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 10\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 25\text{ mA}$)	GPE	13	16	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 10\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 25\text{ mA}$)	η	40	—	—	%
Intermodulation Distortion (1) ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 10\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 25\text{ mA}$)	IMD(d3)	—	-35	-30	dB
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 10\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 25\text{ mA}$, VSWR 30:1 at All Phase Angles)		No Degradation in Output Power			

CLASS A PERFORMANCE

Power Gain and Intermodulation Distortion (1) ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 4\text{ W (PEP)}$, $I_{CQ} = 500\text{ mA}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$)	GPE	—	17	—	dB
	IMD(d3)	—	40	—	dB
	IMD(d5)	—	65	—	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference each tone.

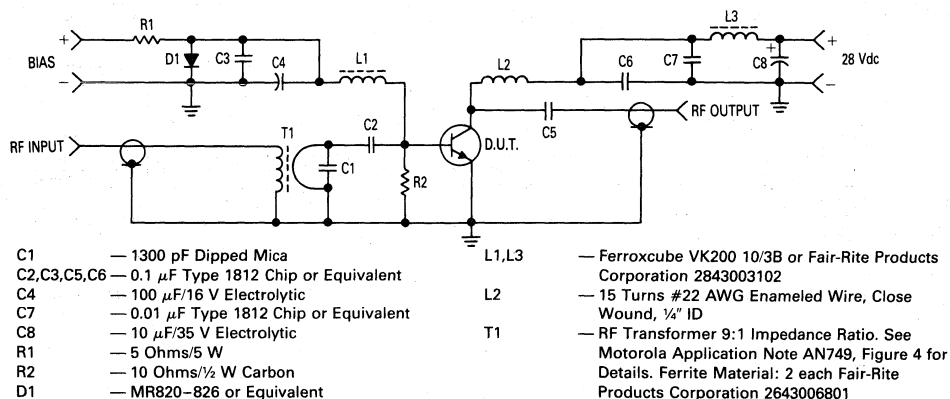


Figure 1. 30 MHz Test Circuit

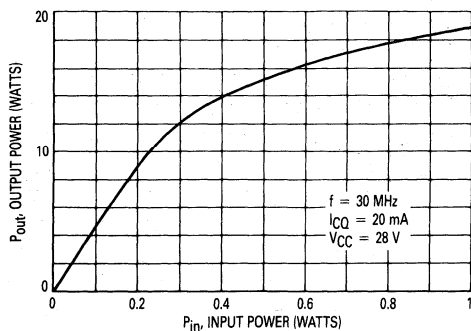


Figure 2. Output Power versus Input Power

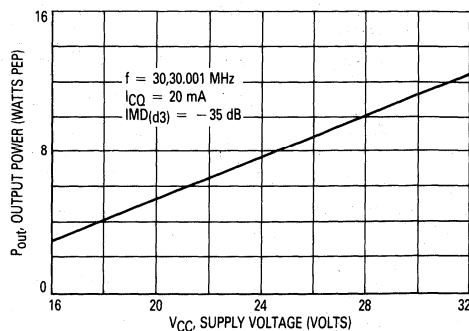


Figure 3. Output Power versus Supply Voltage

MRF410, MRF410A

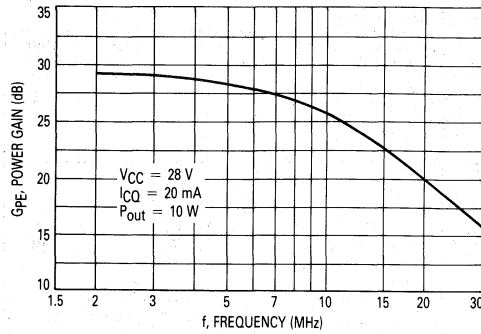


Figure 4. Power Gain versus Frequency

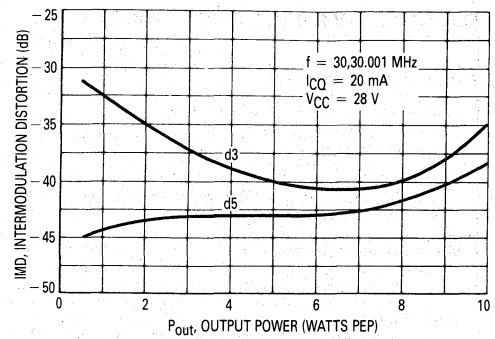


Figure 5. Intermodulation Distortion versus Output Power

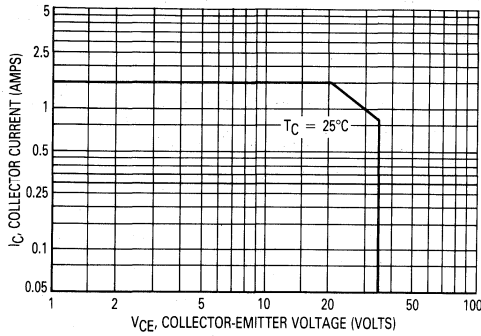


Figure 6. D.C. Safe Operating Area

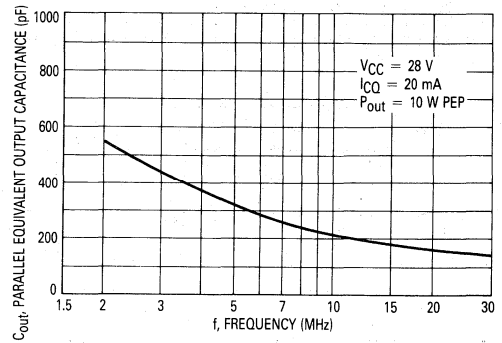


Figure 7. Output Capacitance versus Frequency

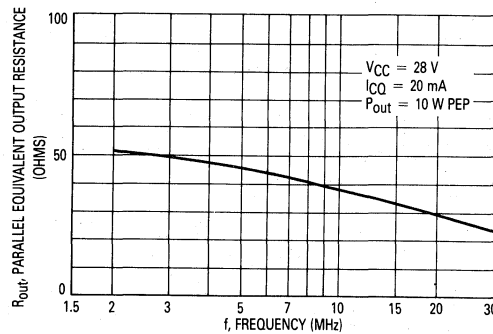


Figure 8. Output Resistance versus Frequency

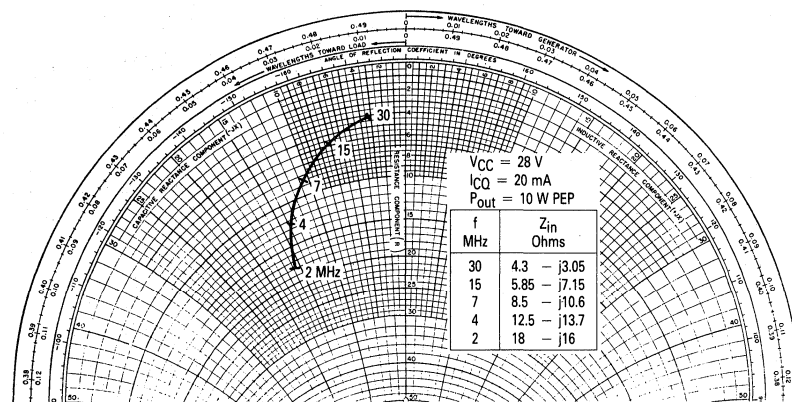


Figure 9. Series Equivalent Input Impedance

MRF421
MRF421MP

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for application as a high-power linear amplifier from 2.0 to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
Output Power = 100 W(PEP)
Minimum Gain = 10 dB
Efficiency = 40%
- Intermodulation Distortion @ 100 W (PEP) —
IMD = -30 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with
30:1 VSWR

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Withstand Current — 10 s	—	30	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	290 1.66	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

MRF421MP is for ordering an hFE matched pair.

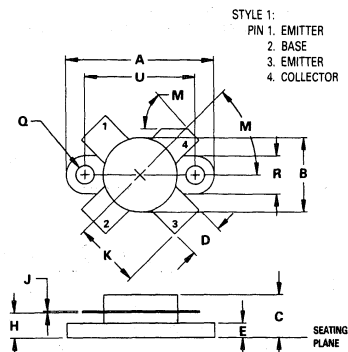
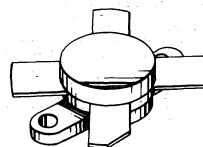
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	$^\circ\text{C/W}$

100 W(PEP) — 30 MHz

**RF POWER
TRANSISTORS**

NPN SILICON



- NOTES:
1. DIMENSIONING AND TOLERANCING PER
ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.86	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 200 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 200 \text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 16 \text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	10	mA

DC Current Gain ($I_C = 5.0 \text{ A dc}$, $V_{CE} = 5.0 \text{ V dc}$)	h_{FE}	10	30	—	—
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Output Capacitance ($V_{CR} = 12.5 \text{ Vdc}$, $I_F = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	650	800	pF
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Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5$ Vdc, $P_{out} = 100$ W, $I_{C(max)} = 10$ Adc, $I_{CQ} = 150$ mA, $f = 30, 30.001$ MHz)	GPE	10	12	—	dB
Collector Efficiency ($V_{CC} = 12.5$ Vdc, $P_{out} = 100$ W, $I_{C(max)} = 10$ Adc, $I_{CQ} = 150$ mA, $f = 30, 30.001$ MHz)	η	40	—	—	%
Intermodulation Distortion (1) ($V_{CE} = 12.5$ Vdc, $P_{out} = 100$ Watts, $I_C = 10$ Adc, $I_{CQ} = 150$ mA, $f = 30, 30.001$ MHz)	IMD	—	-33	-30	dB

FIGURE 1 – 30 MHz TEST CIRCUIT SCHEMATIC

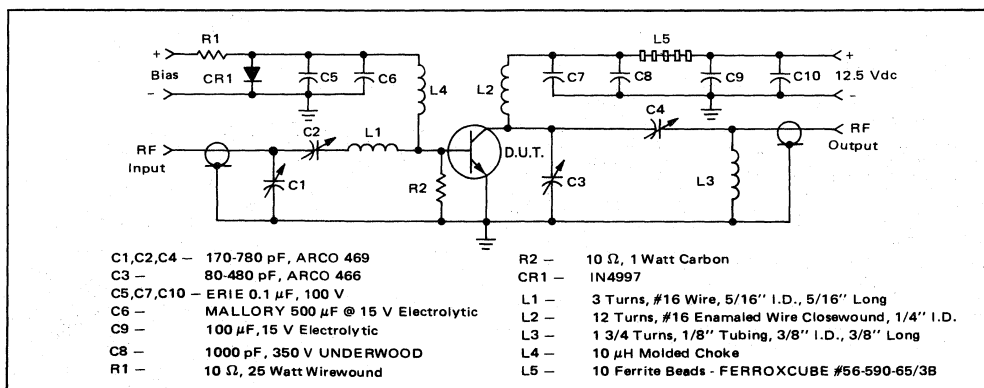


FIGURE 2 – OUTPUT POWER versus INPUT POWER

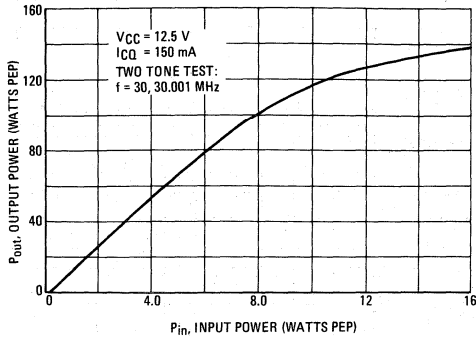


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

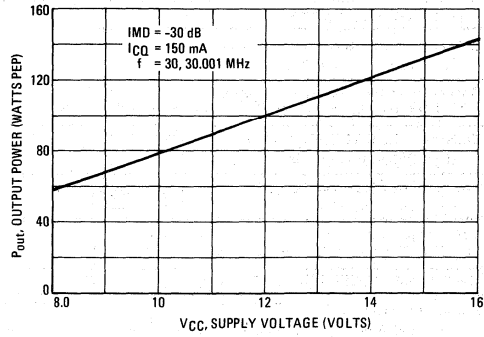


FIGURE 4 – POWER GAIN versus FREQUENCY

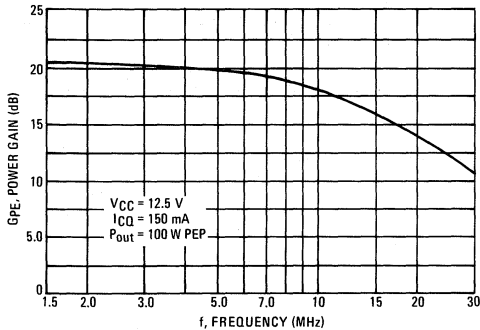


FIGURE 5 – INTERMODULATION DISTORTION versus OUTPUT POWER

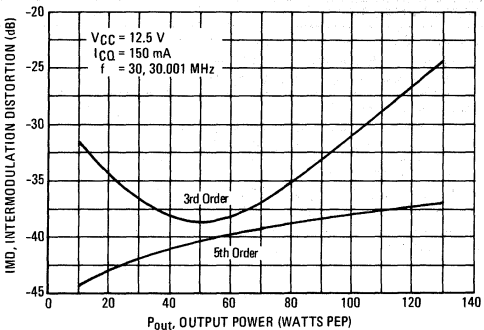


FIGURE 6 – DC SAFE OPERATING AREA

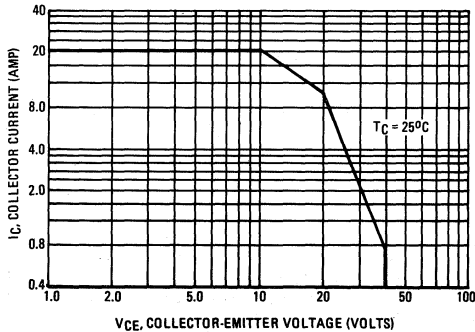


FIGURE 7 – SERIES EQUIVALENT IMPEDANCE

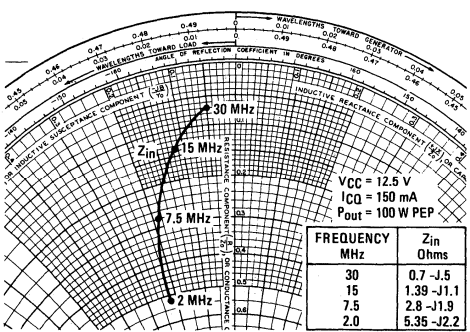


FIGURE 8 – OUTPUT CAPACITANCE versus FREQUENCY

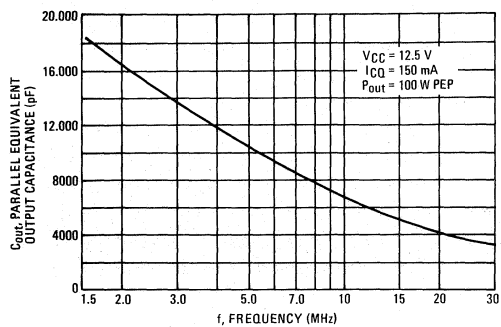
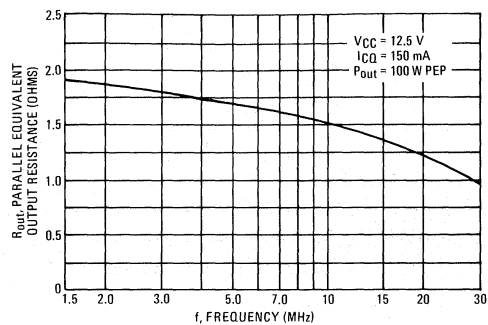


FIGURE 9 – OUTPUT RESISTANCE versus FREQUENCY



MRF422
MRF422MP

The RF Line

NPN SILICON RF POWER TRANSISTORS

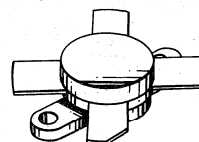
... designed primarily for applications as a high-power linear amplifier from 2.0 to 30 MHz.

- Specified 28 Volt, 30 MHz Characteristics —
Output Power = 150 W(PEP)
Minimum Gain = 10 dB
Efficiency = 40%
- Intermodulation Distortion @ 150 W(PEP) —
IMD = -30 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with
30:1 VSWR

150 W(PEP) — 30 MHz

RF POWER
TRANSISTORS

NPN SILICON



MAXIMUM RATINGS

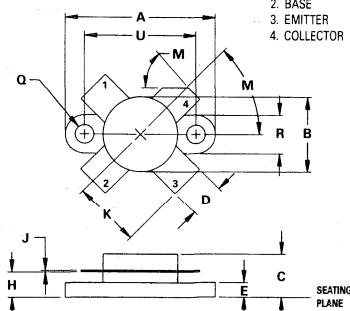
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	85	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Withstanding Current — 10 s	—	30	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	290 1.66	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

MRF422MP is for ordering a HFE matched pair.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	$^\circ\text{C}/\text{W}$

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



- NOTES:
1. DIMENSIONING AND TOLERANCING PER
ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	85	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	85	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	20	mAac
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	420	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 150\text{ W(PEP)}$, $I_{C(max)} = 6.7\text{ Adc}$, $I_{CQ} = 150\text{ mAac}$, $f = 30, 30.001\text{ MHz}$)	G_{PE}	10	13	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 150\text{ W(PEP)}$, $I_{C(max)} = 6.7\text{ Adc}$, $I_{CQ} = 150\text{ mAac}$, $f = 30, 30.001\text{ MHz}$)	η	—	45	—	%
Intermodulation Distortion * ($V_{CE} = 28\text{ Vdc}$, $P_{out} = 150\text{ Watts(PEP)}$, $I_C = 6.7\text{ Adc}$, $I_{CQ} = 150\text{ mAac}$, $f = 30, 30.001\text{ MHz}$)	IMD	—	-33	-30	dB
Output Power ($V_{CE} = 28\text{ Vdc}$, $f = 30\text{ MHz}$)	P_{out}	150	—	—	Watts PEP

*To Mil Std 1311 Version A, Test Method 2204, Two Tone, Reference each Tone.

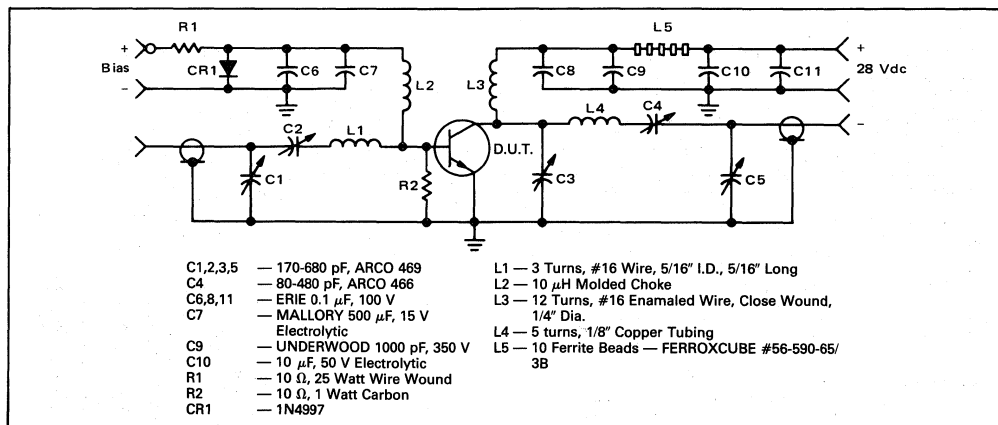
FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC

FIGURE 2 – OUTPUT POWER versus INPUT POWER

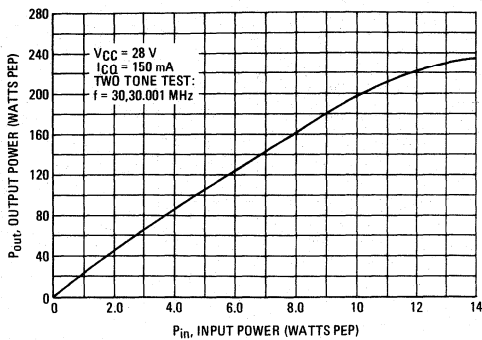


FIGURE 3 – POWER GAIN versus FREQUENCY

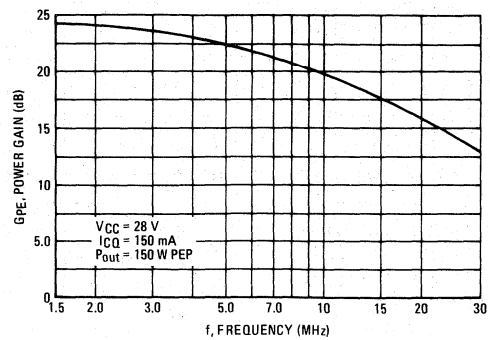


FIGURE 4 – LINEAR OUTPUT POWER versus SUPPLY VOLTAGE

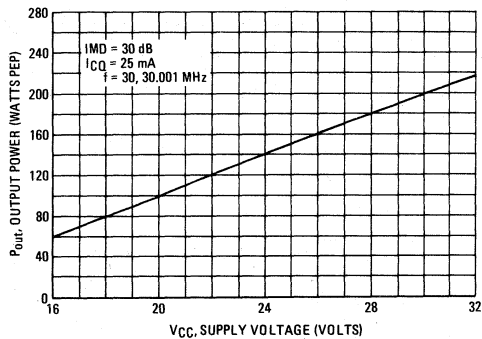


FIGURE 5 – INTERMODULATION DISTORTION versus OUTPUT POWER

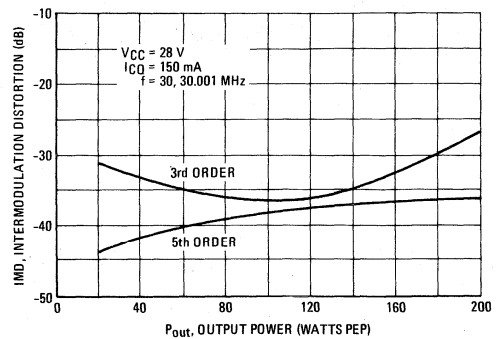


FIGURE 6 – DC SAFE OPERATING AREA

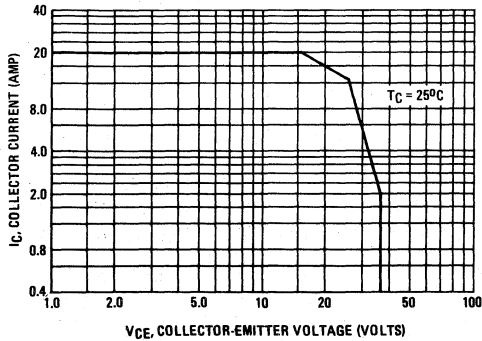


FIGURE 7 – SERIES INPUT IMPEDANCE

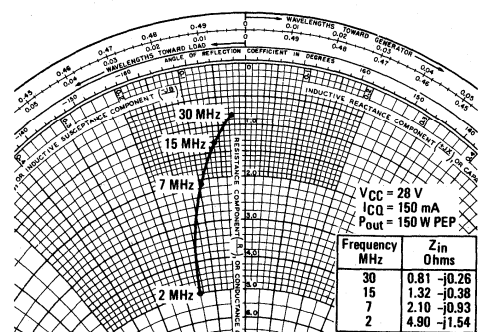


FIGURE 8 – OUTPUT RESISTANCE versus FREQUENCY

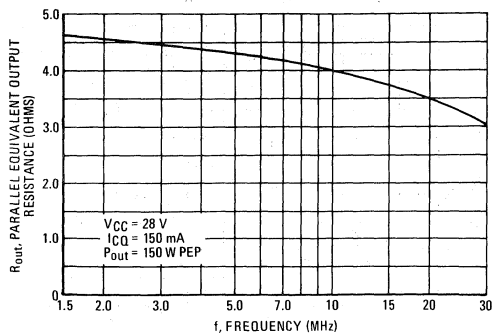
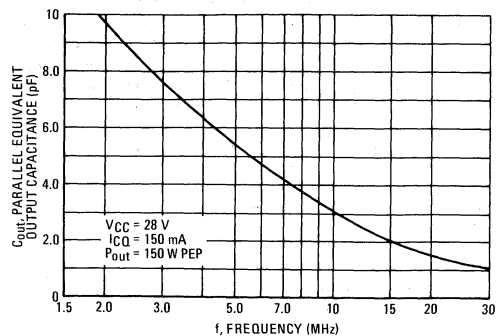


FIGURE 9 – OUTPUT CAPACITANCE versus FREQUENCY



MRF426

The RF Line

NPN SILICON RF POWER TRANSISTOR

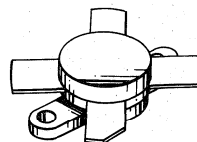
... designed for high gain driver and output linear amplifier stages in 1.5 to 30 MHz HF/SSB equipment.

- Specified 28 Volt, 30 MHz Characteristics –
Output Power = 25 W (PEP)
Minimum Gain = 22 dB
Efficiency = 35%
- Intermodulation Distortion @ 25 W (PEP) –
IMD = -30 dB (Max)
- 100% Tested for Load Mismatch at All Phase Angles
With 30:1 VSWR
- Class A and AB Characterization
- BLX 13 Equivalent

25 W (PEP) – 30 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



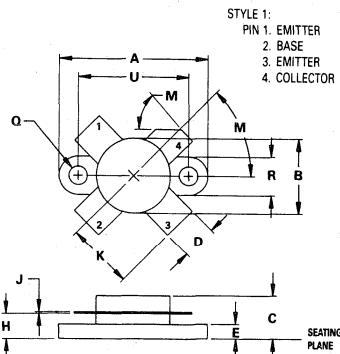
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	3.0	Adc
Withstand Current – 5 s	—	6.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	70 0.4	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM	—	45° NOM	—
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	10	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	35	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	60	80	pF
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FUNCTIONAL TESTS (SSB)

Common-Emitter Amplifier Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 25\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 25\text{ mA}$)	G_{PE}	22	25	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 25\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 25\text{ mA}$)	η	35	—	—	%
Intermodulation Distortion (1) ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 25\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 25\text{ mA}$)	$IMD_{(d3)}$	—	-35	-30	dB
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 25\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 25\text{ mA}$, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			

CLASS A PERFORMANCE

Intermodulation Distortion (1) and Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 8\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 1.2\text{ A}$)	G_{PE}	—	23.5	—	dB
	$IMD_{(d3)}$	—	-40	—	dB
	$IMD_{(d5)}$	—	-55	—	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 - 30 MHz LINEAR TEST CIRCUIT

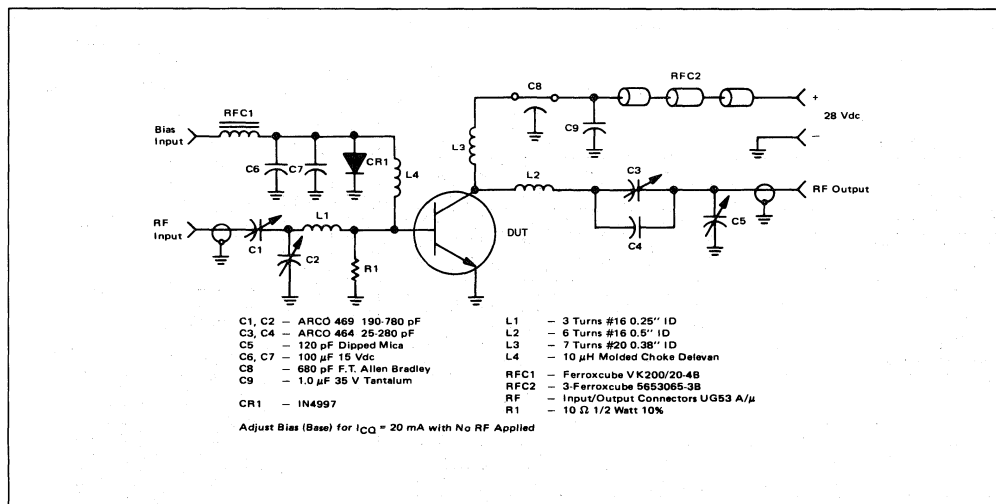


FIGURE 2 – OUTPUT POWER versus INPUT POWER

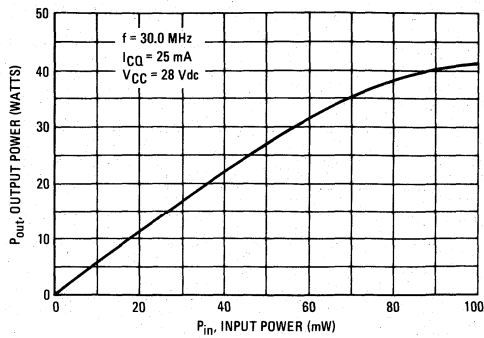


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

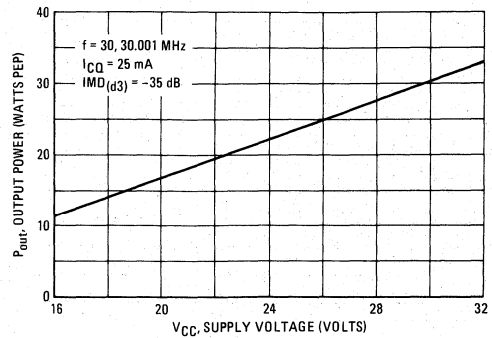


FIGURE 4 – POWER GAIN versus FREQUENCY

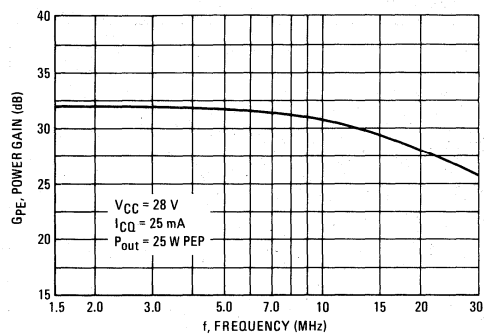


FIGURE 5 – INTERMODULATION DISTORTION versus OUTPUT POWER

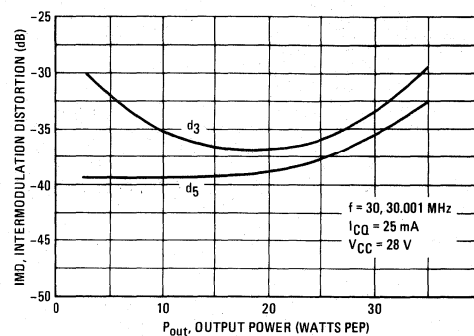


FIGURE 6 – DC SAFE OPERATING AREA

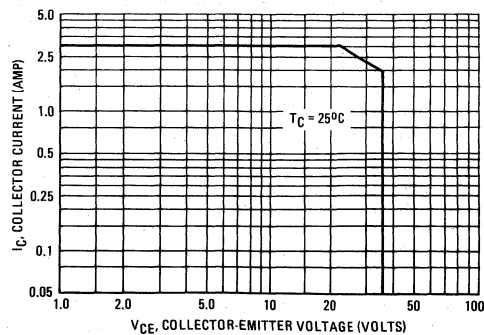


FIGURE 7 — OUTPUT CAPACITANCE versus FREQUENCY

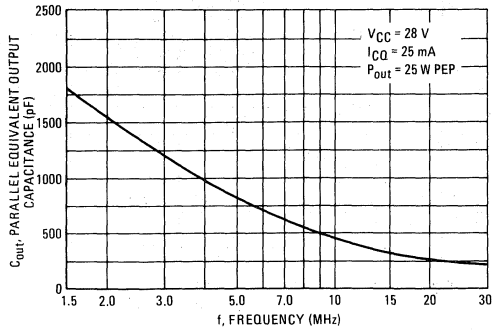


FIGURE 8 — OUTPUT RESISTANCE versus FREQUENCY

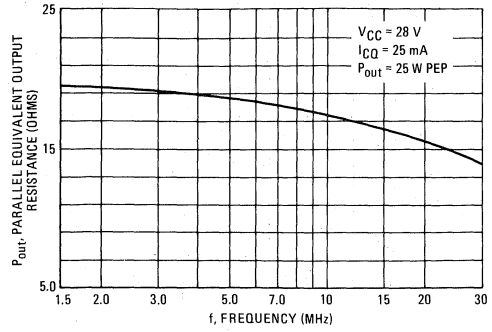
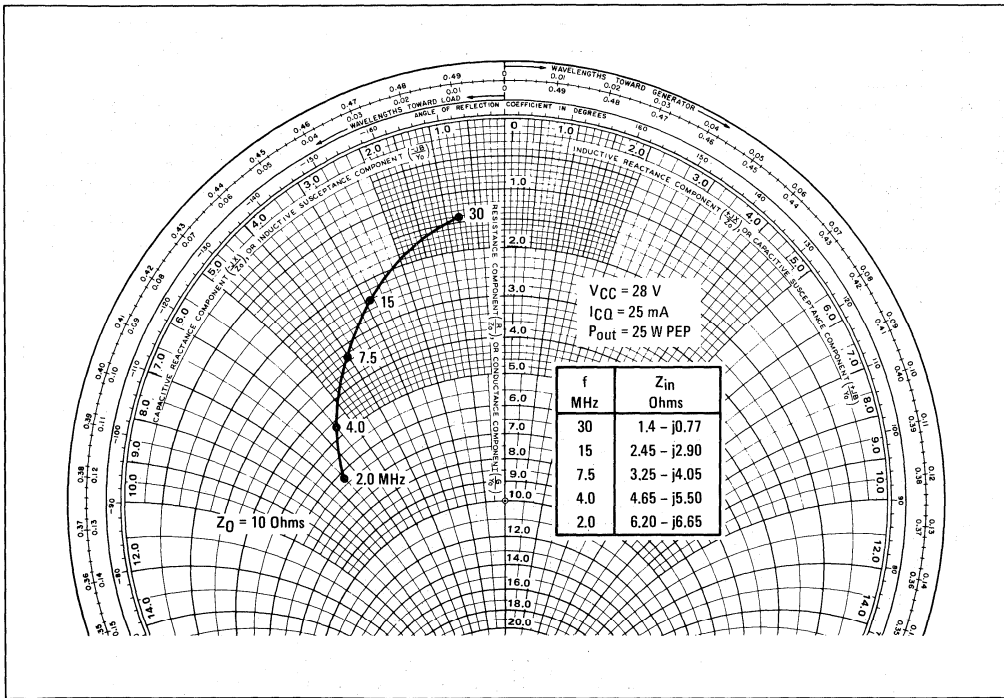


FIGURE 9 — SERIES EQUIVALENT INPUT IMPEDANCE



The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics —
Output Power = 25 W(PEP)
Minimum Gain = 18 dB
- Intermodulation Distortion @ 25 W(PEP) —
IMD = -34 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR

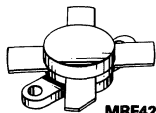
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	65	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	6.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	80 0.457	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.19	$^\circ\text{C/W}$

CASE 211-11



MRF427

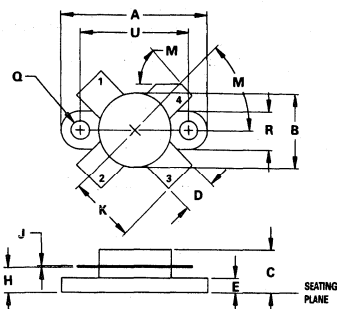
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM	45° NOM	—	—
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

STYLE 1:

- PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

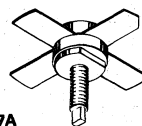


MRF427
MRF427A

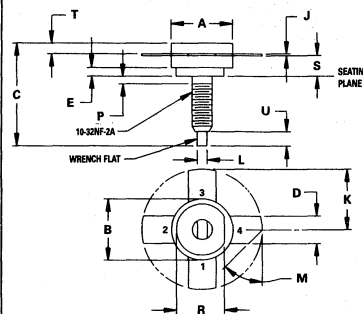
25 W (PEP) — 30 MHz

RF POWER TRANSISTOR

NPN SILICON



MRF427A



STYLE 1:

- PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

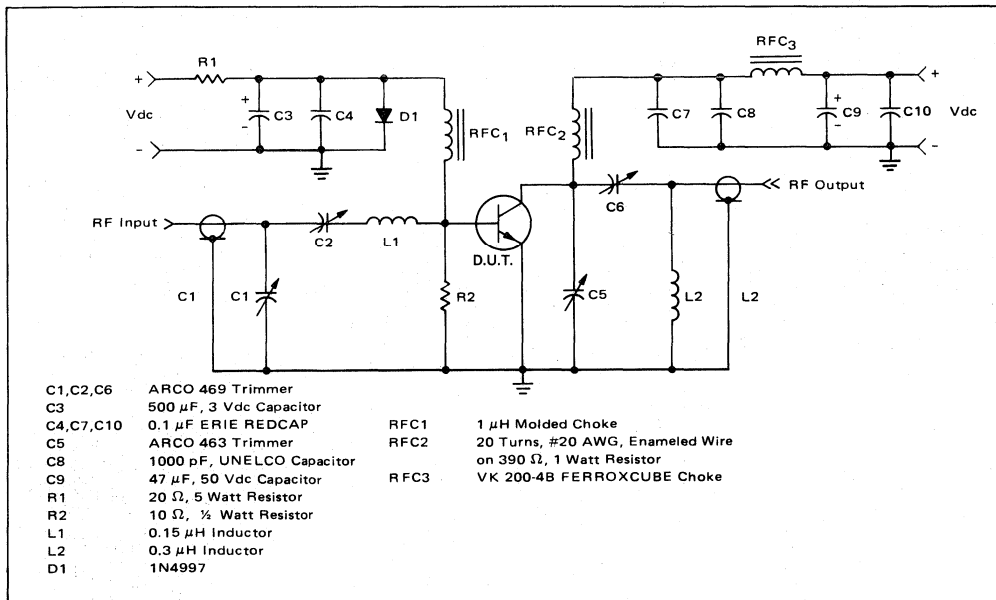
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	12.45	12.95	0.490	0.510
B	10.54	10.80	0.415	0.425
C	19.68	22.73	0.775	0.895
D	5.46	5.97	0.215	0.235
E	1.83	—	0.072	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.65	1.90	0.065	0.075
M	45° NOM	45° NOM	—	—
P	—	1.27	—	0.050
R	9.73	10.06	0.383	0.396
S	3.84	4.50	0.151	0.177
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-10

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	65	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	110	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	110	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 500\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	15	—	90	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	60	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 25\text{ W(PEP)}$, $f = 30\text{ MHz}$)	G_{pe}	18	20	—	dB
Intermodulation Distortion ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 25\text{ W(PEP)}$)	IMD	-34	-37	—	dB
Electrical Ruggedness ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 25\text{ W(PEP)}$, $f = 30\text{ MHz}$, VSWR 30:1) All Phase Angles	—	No Degradation in Output Power			

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



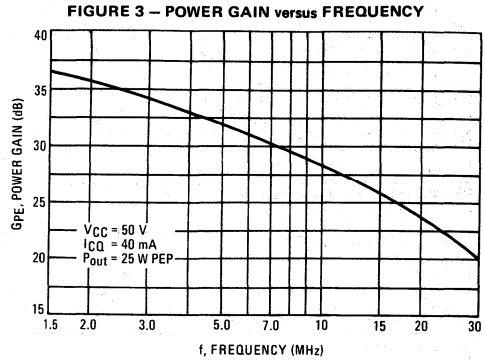
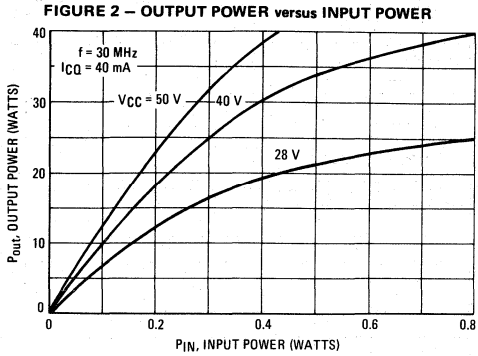


FIGURE 4 – INTERMODULATION DISTORTION versus OUTPUT POWER
 $V_{CC} = 50 V_{dc}$

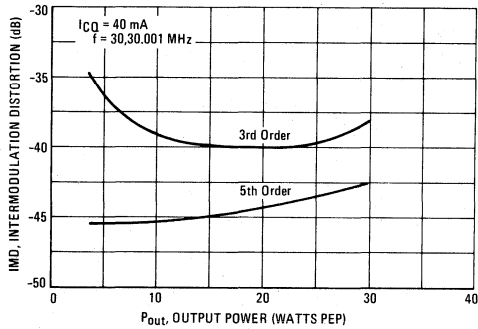


FIGURE 5 – INTERMODULATION DISTORTION versus OUTPUT POWER
 $V_{CC} = 40 V_{dc}$

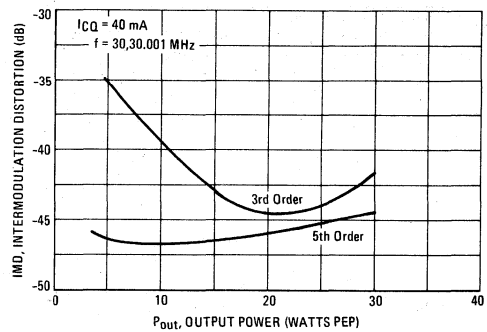


FIGURE 6 – OUTPUT RESISTANCE versus FREQUENCY

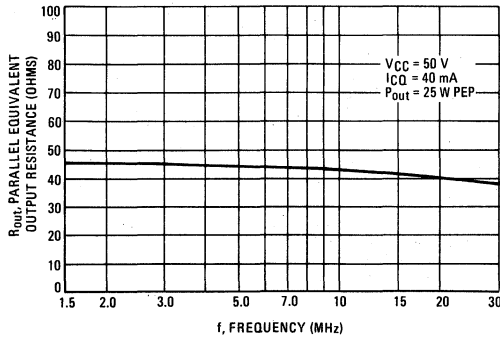


FIGURE 7 – OUTPUT CAPACITANCE versus FREQUENCY

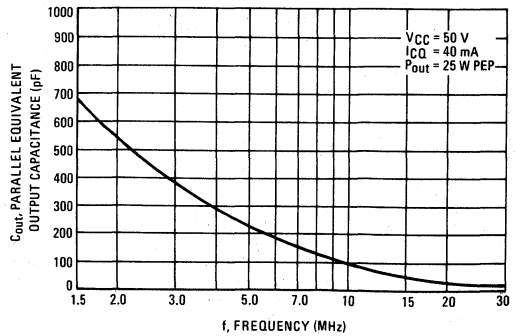


FIGURE 8 — OUTPUT POWER versus SUPPLY VOLTAGE

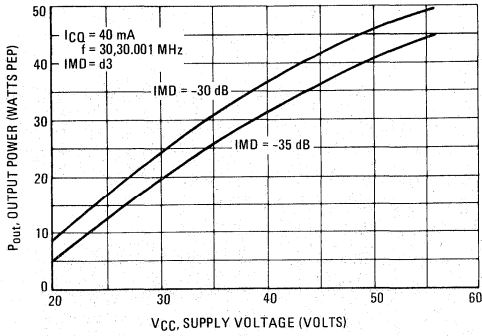


FIGURE 9 — DC SAFE OPERATING AREA

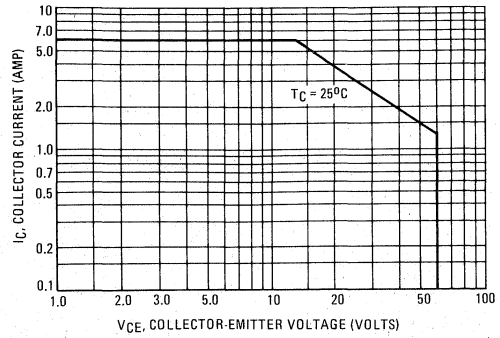
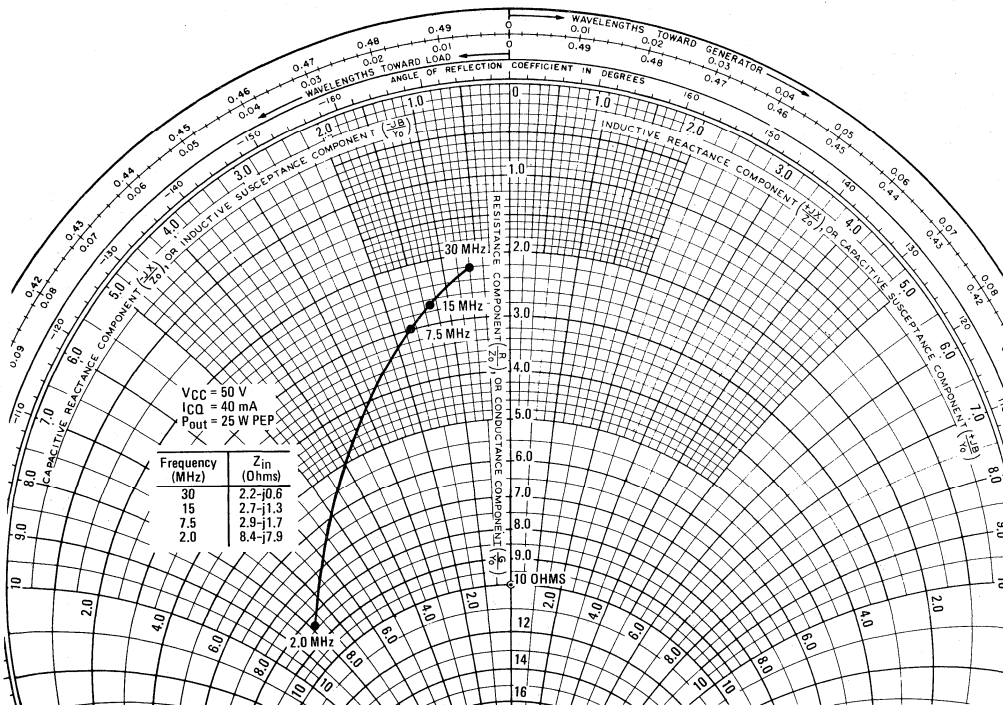


FIGURE 10 — SERIES EQUIVALENT IMPEDANCE



MRF428

The RF Line

NPN SILICON RF POWER TRANSISTOR

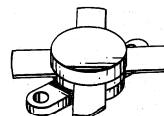
... designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics —
Output Power = 150 W(PEP)
Minimum Gain = 13 dB
Efficiency = 45%
- Intermodulation Distortion @ 150 W (PEP) —
IMD = -30 dB (Max)
- 100% Tested for Load Mismatch at all Phase Angles with
30:1 VSWR

150 W (PEP) — 30 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



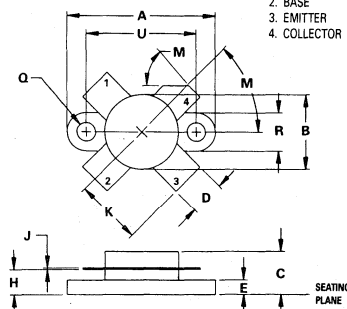
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	55	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Withstand Current — 10 s	—	30	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	320 1.83	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.5	$^\circ\text{C/W}$

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



- NOTES:
1. DIMENSIONING AND TOLERANCING PER
ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.06	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA dc}$, $I_B = 0$)	$V_{(BR)CEO}$	55	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA dc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	110	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mA dc}$, $I_E = 0$)	$V_{(BR)CBO}$	110	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA dc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ A dc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	200	250	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Gain ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 150\text{ W (PEP)}$, $I_C(\text{max}) = 3.32\text{ A dc}$, $f = 30\text{ MHz}$)	G_{PE}	13	15	—	dB
Output Power ($V_{CE} = 50\text{ Vdc}$, $f = 30\text{ MHz}$)	P_{out}	150	—	—	W PEP
Collector Efficiency ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 150\text{ W (PEP)}$, $I_C(\text{max}) = 3.32\text{ A dc}$, $f = 30\text{ MHz}$)	η	45	—	—	%
Intermodulation Distortion (1) ($V_{CE} = 50\text{ Vdc}$, $P_{out} = 150\text{ W (PEP)}$, $I_C = 3.32\text{ A dc}$)	IMD	—	-33	-30	dB
Electrical Ruggedness ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 150\text{ W (PEP)}$, $I_C(\text{max}) = 3.32\text{ A dc}$, $f = 30\text{ MHz}$) VSWR 30:1 at all Phase Angles	No Degradation in Output Power				

(1) To Mil Std 1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC

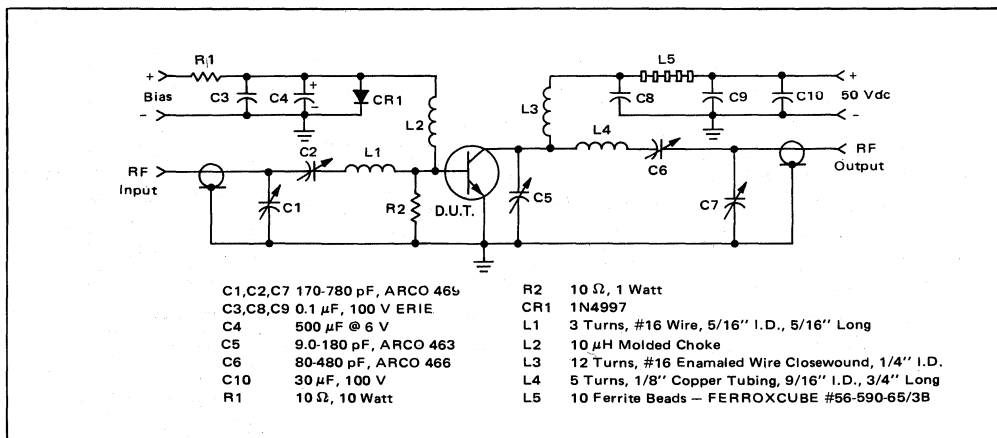


FIGURE 2 – OUTPUT POWER versus INPUT POWER

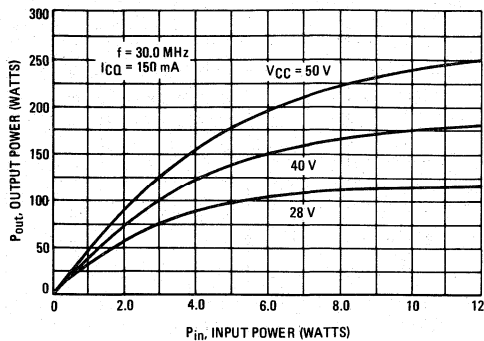


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

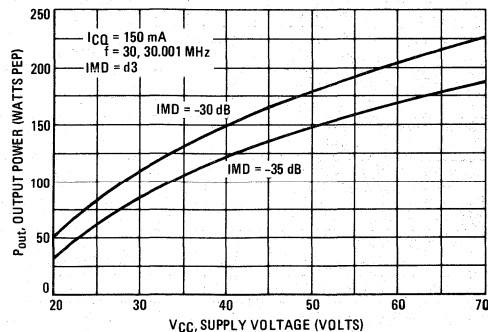


FIGURE 4 – POWER GAIN versus FREQUENCY

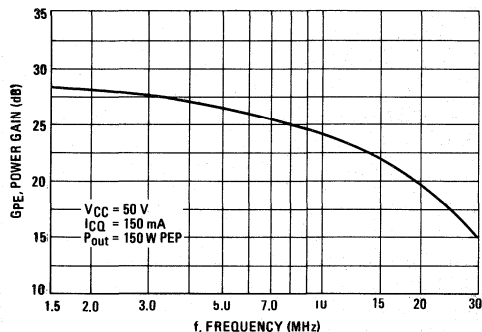
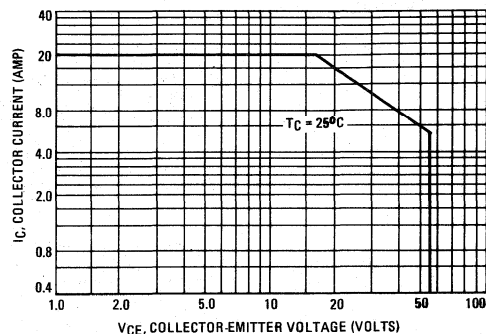


FIGURE 5 – DC SAFE OPERATING AREA



INTERMODULATION DISTORTION versus OUTPUT POWER

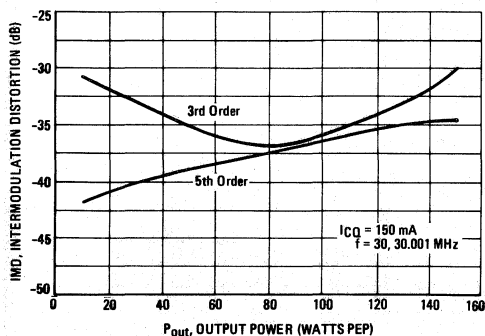
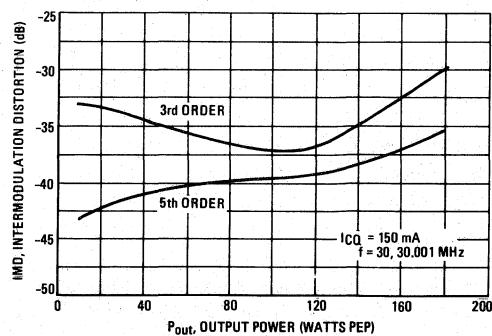
FIGURE 6 – $V_{CC} = 40$ VdcFIGURE 7 – $V_{CC} = 50$ Vdc

FIGURE 8 — OUTPUT CAPACITANCE versus FREQUENCY

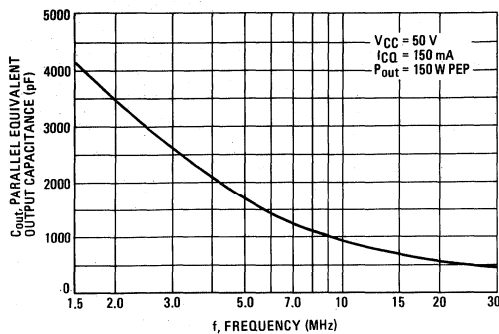


FIGURE 9 — OUTPUT RESISTANCE versus FREQUENCY

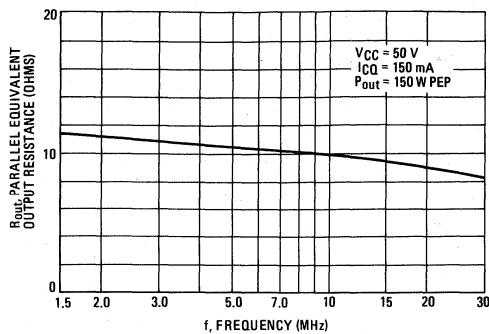
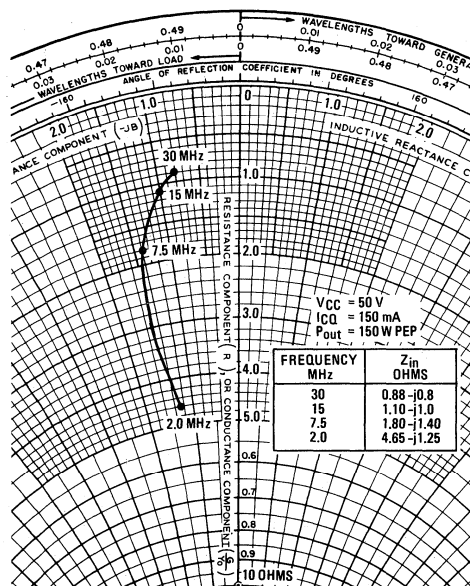


FIGURE 10 — SERIES EQUIVALENT IMPEDANCE



MRF429
MRF429MP

The RF Line

NPN SILICON RF POWER TRANSISTORS

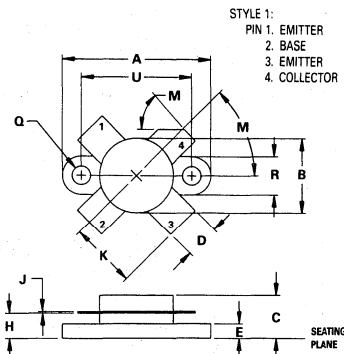
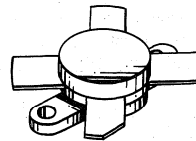
... designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics —
Output Power = 150 W(PEP)
Minimum Gain = 13 dB
Efficiency = 45%
- Intermodulation Distortion @ 150 W(PEP) —
IMD = -32 dB (Max)
- Diffused Emitter Resistors for Superior Ruggedness
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR @ 150 W CW

150 W (LINEAR) 30 MHz

**RF POWER
TRANSISTORS**

NPN SILICON



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45°	NOM	45°	NOM
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Withstand Current — 10 s	—	20	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	320 1.33	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

MRF429MP is for ordering an hfg matched pair.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.75	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA dc}$, $I_B = 0$)	$V_{(BR)CEO}$	50	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA dc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	100	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mA dc}$, $I_E = 0$)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA dc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ A dc}$, $V_{CE} = 5.0\text{ V dc}$)	h_{FE}	10	30	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 50\text{ V dc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	220	300	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Gain ($V_{CC} = 50\text{ V dc}$, $P_{out} = 150\text{ W (PEP)}$, $I_C(\text{max}) = 3.32\text{ A dc}$, $f = 30$; 30.001 MHz)	G_{PE}	13	15	—	dB
Output Power ($V_{CE} = 50\text{ V dc}$, $f = 30$; 30.001 MHz)	P_{out}	150	—	—	W (PEP)
Collector Efficiency ($V_{CC} = 50\text{ V dc}$, $P_{out} = 150\text{ W (PEP)}$, $I_C(\text{max}) = 3.32\text{ A dc}$, $f = 30$; 30.001 MHz)	η	45	—	—	%
Intermodulation Distortion (1) ($V_{CE} = 50\text{ V dc}$, $P_{out} = 150\text{ W (PEP)}$, $I_C = 3.32\text{ A dc}$)	IMD	—	-35	-32	dB
Electrical Ruggedness ($V_{CC} = 50\text{ V dc}$, $P_{out} = 150\text{ W CW}$, $f = 30\text{ MHz}$, VSWR 30:1 at all Phase Angles)	No Degradation in Output Power				

(1) To Mil Std 1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC

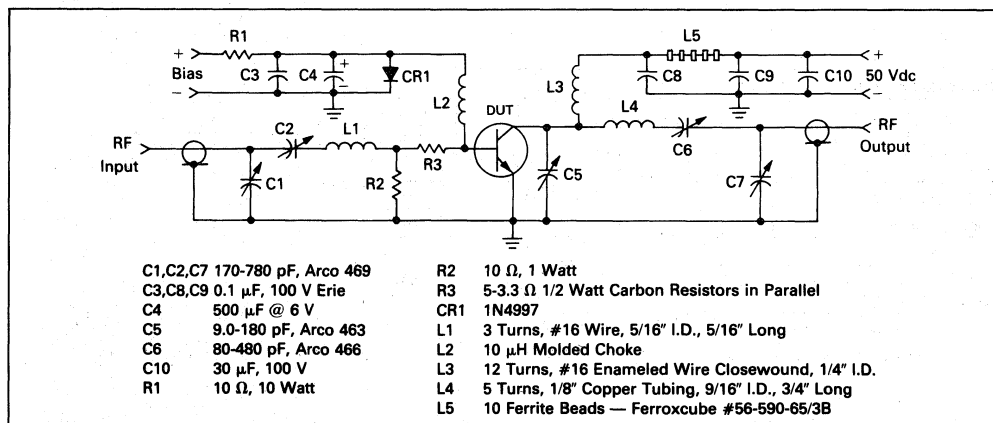


FIGURE 2 — OUTPUT POWER versus INPUT POWER

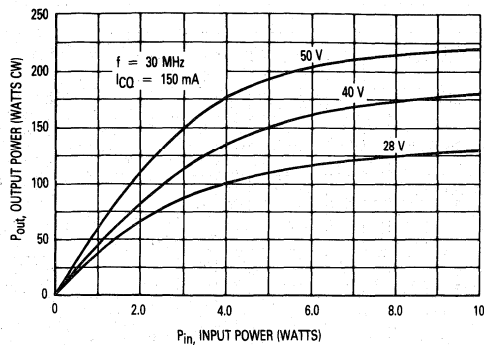


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

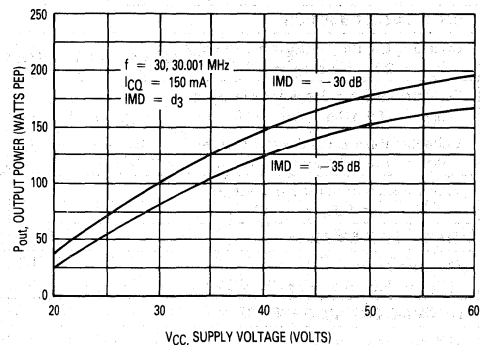


FIGURE 4 — POWER GAIN versus FREQUENCY

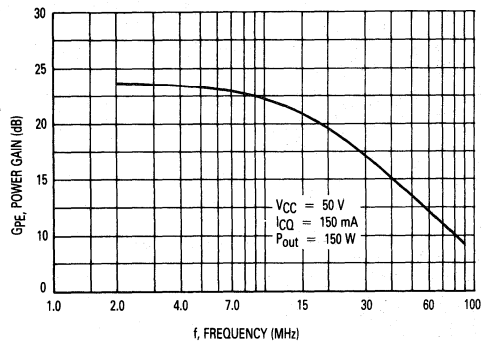


FIGURE 5 — RF SAFE OPERATING AREA (SOAR)

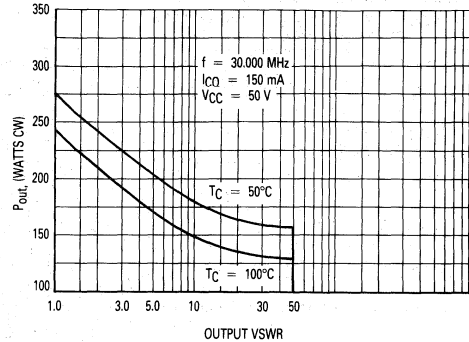


FIGURE 6 — f_T versus COLLECTOR CURRENT

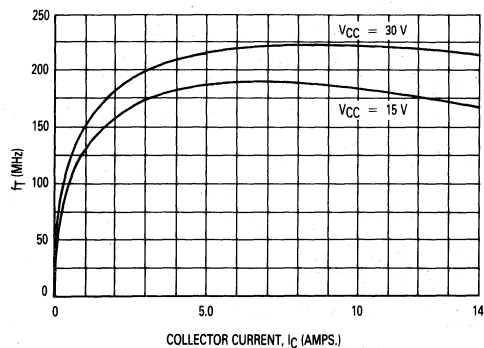


FIGURE 7 — IMD versus P_{out}

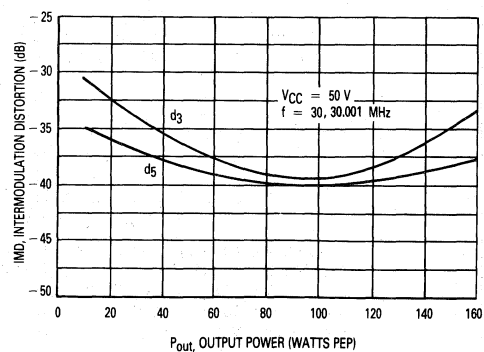


FIGURE 8 — OUTPUT CAPACITANCE versus FREQUENCY

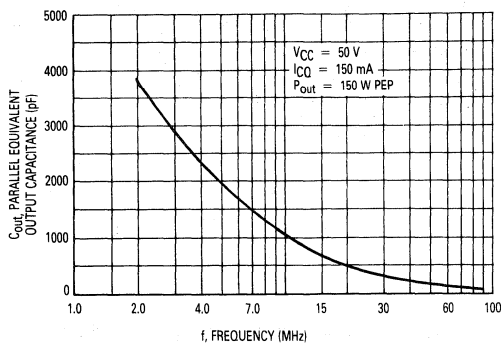


FIGURE 9 — OUTPUT RESISTANCE versus FREQUENCY

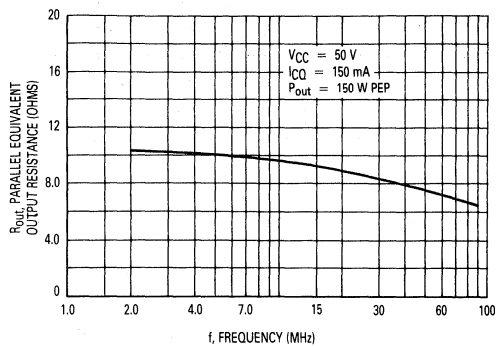
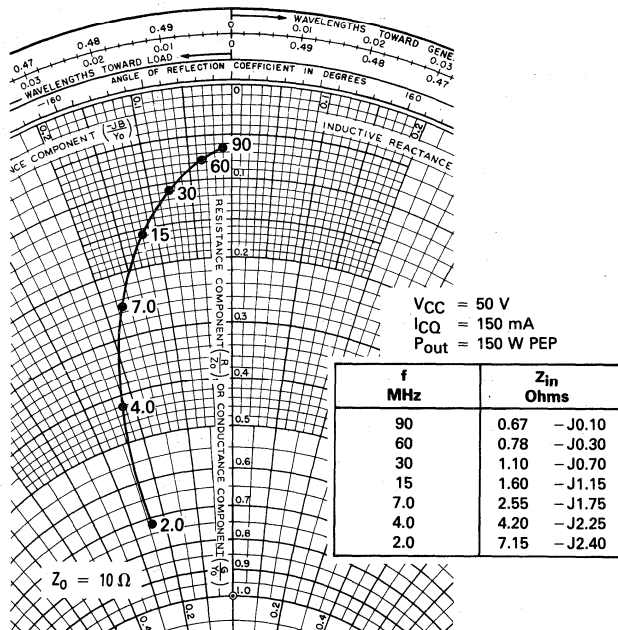


FIGURE 10 — SERIES EQUIVALENT IMPEDANCE



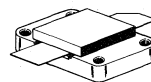
The RF Line
NPN Silicon
RF Power Transistor

... designed primarily for high-voltage applications as a high-power linear amplifier from 2 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics
 - Output Power = 600 W
 - Minimum Gain = 10 dB
 - Efficiency = 40%
- Intermodulation Distortion @ 600 W(PEP) — IMD = -30 dB
- Diffused Emitter Resistors for Superior Ruggedness
- Low Thermal Resistance

MRF430

600 WATTS (LINEAR)
30 MHz
RF POWER TRANSISTOR
NPN SILICON



CASE 368-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	60	Adc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate Above 25°C	P_D	875 5	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.20	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 500 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	50	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 200 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	110	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 20 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 20 \text{ Adc}$, $V_{CE} = 10 \text{ Vdc}$)	h_{FE}	10	30	80	—
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(continued)

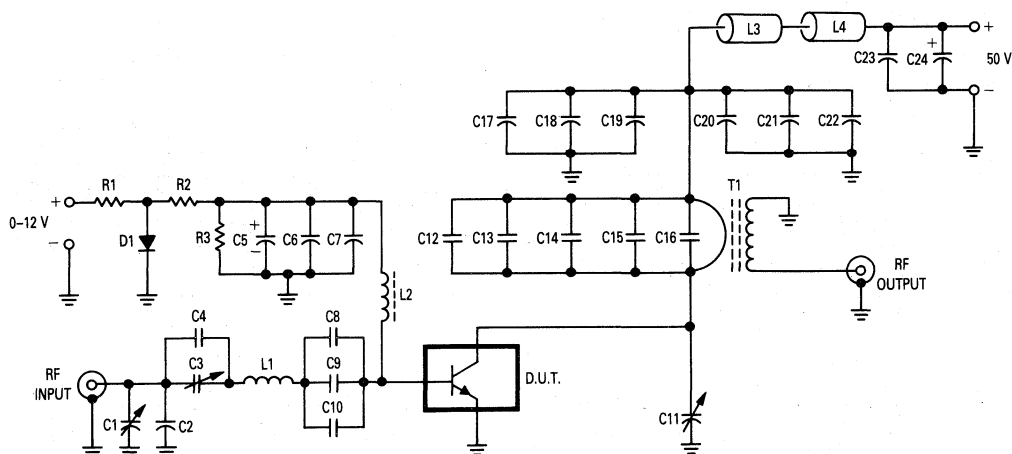
ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	900	1200	pF

FUNCTIONAL TEST

Common-Emitter Amplifier Power Gain ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 600\text{ W}$ (CW), $f = 30\text{ MHz}$, $I_{CQ} = 600\text{ mA}$)	G_{pE}	10	13	—	dB
Collector Efficiency ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 600\text{ W}$, $f = 30\text{ MHz}$, $I_{CQ} = 600\text{ mA}$)	η	—	40	—	%
		—	60	—	%
Intermodulation Distortion (1) ($V_{CE} = 50\text{ Vdc}$, $P_{out} = 600\text{ W}$ (PEP), $I_{CQ} = 600\text{ mA}$, $f = 30\text{ MHz}$)	IMD	—	-30	—	dB

(1) To Mil Std 1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



C1, C3, C11 — Arco 469 or equivalent
 C2 — 820 pF
 C4 — 330 pF
 C5 — 1000 $\mu\text{F}/3\text{ V}$ Electrolytic
 C6, C8, C9, C10, C17, C18, C19 — 0.1 μF
 C7, C22, C23 — 0.47 μF , RMC Type 2225C or equivalent
 C12, C13, C14 — 470 pF
 C15 — 1000 pF
 C16 — Two Unencapsulated 1000 pF Mica in Series
 C20, C21 — 0.039 μF
 C24 — 10 $\mu\text{F}/100\text{ V}$ Electrolytic
 D1 — 1N4997 or equivalent
 R1 — 10 Ohms/10 W
 R2 — 0.1 Ohm/ $\frac{1}{2}\text{ W}$
 R3 — 2.7 Ohms/2 W

L1 — 2 Turns #14 AWG, $\frac{1}{2}$ " ID, $\frac{1}{2}$ " Long
 L2 — Ohmite Z-235 or equivalent
 L3, L4 — Ferrite Beads, Fair-Rite Products Corp. #2673000801 or equivalent
 T1 — RF Transformer, 1:25 Impedance Ratio. See Motorola Application Note AN749, Figure 4 for details. Ferrite Material: 2 Each, Fair-Rite Product Corp. #2667540001 or equivalent

All capacitors ATC type 100/200 chips or equivalent, unless otherwise noted.

Figure 1. 30 MHz Test Circuit Schematic

TYPICAL CHARACTERISTICS

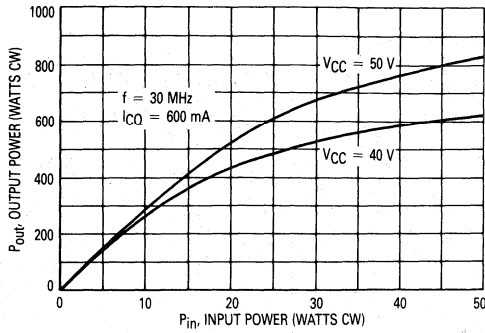


Figure 2. Output Power versus Input Power

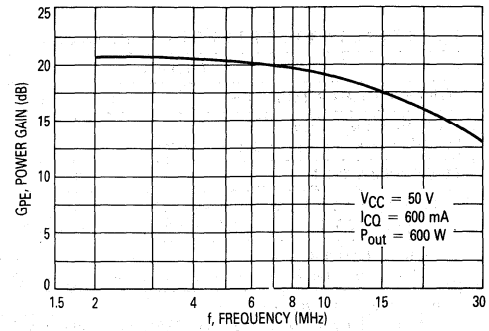


Figure 3. Power Gain versus Frequency

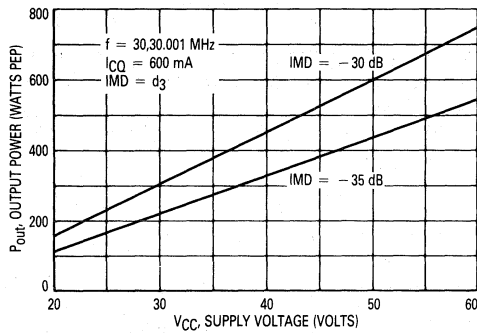


Figure 4. Output Power versus Supply Voltage

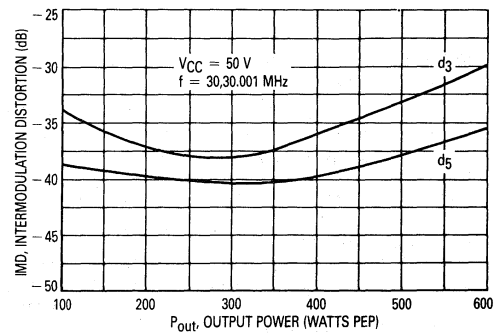


Figure 5. IMD versus Output Power

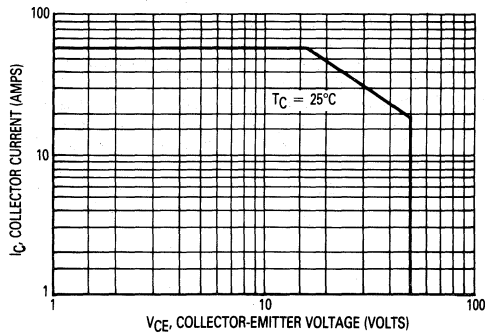
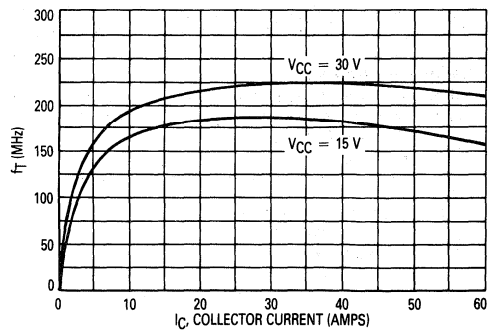


Figure 6. DC Safe Operating Area

Figure 7. f_T versus Collector Current

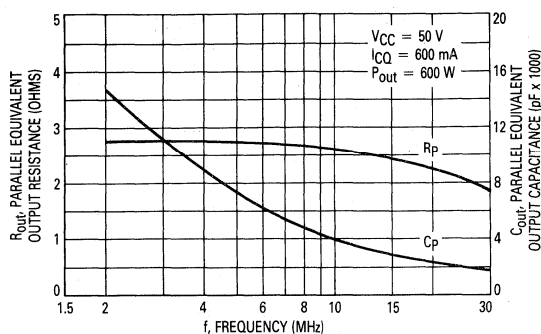


Figure 8. Output Resistance and Capacitance versus Frequency

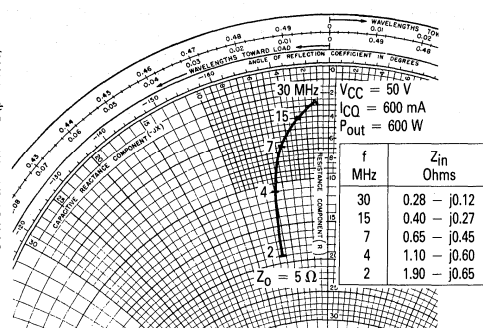


Figure 9. Series Equivalent Input Impedance

MOUNTING OF HIGH POWER RF POWER TRANSISTORS

The package of this device is designed for conduction cooling. It is extremely important to minimize the thermal resistance between the device flange and the heat dissipator.

Since the device mounting flange is made of soft copper, it may be deformed during various stages of handling or during transportation. It is recommended that the user makes a final inspection on this before the device installation. ± 0.0005 " is considered sufficient for the flange bottom.

The same applies to the heat dissipator in the device mounting area. If copper heatsink is not used, a copper head spreader is strongly recommended between the device mounting surfaces and the main heatsink. It should be at least 1/4" thick and extend at least one inch from the flange edges. A thin layer of thermal compound in all interfaces is, of course, essential. The recommended torque on the 4-40 mounting screws should be in the area of 4-5 lbs.-inch, and spring type lock washers along with flat washers are recommended.

For die temperature calculations, the Δ temperature from a corner mounting screw area to the bottom center

of the flange is approximately 5°C and 10°C under normal operating conditions (dissipation 150 W and 300 W respectively).

The main heat dissipator must be sufficiently large and have low R_{θ} for moderate air velocity, unless liquid cooling is employed.

CIRCUIT CONSIDERATIONS

At high power levels (500 W and up), the circuit layout becomes critical due to the low impedance levels and high RF currents associated with the output matching. Some of the components, such as capacitors and inductors must also withstand these currents. The component losses are directly proportional to the operating frequency. The manufacturers specifications on capacitor ratings should be consulted on these aspects prior to design.

Push-pull circuits are less critical in general, since the ground referenced RF loops are practically eliminated, and the impedance levels are higher for a given power output. High power broadband transformers are also easier to design than comparable LC matching networks.

MRF433

The RF Line

SILICON RF POWER TRANSISTORS

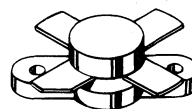
... designed primarily for application as complementary symmetry amplifiers in linear amplifiers from 2.0 to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics –
Output Power = 12.5 W (PEP)
Minimum Gain = 20 dB
Efficiency = 50%
- Intermodulation Distortion @ 12.5 W (PEP) –
IMD = -30 dB (Max)

12.5 W (PEP) – 30 MHz

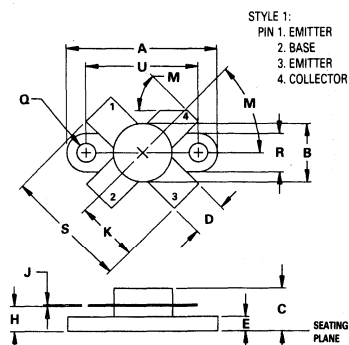
**RF POWER
TRANSISTOR**

NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	20 114	Watts $\text{W}/^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$



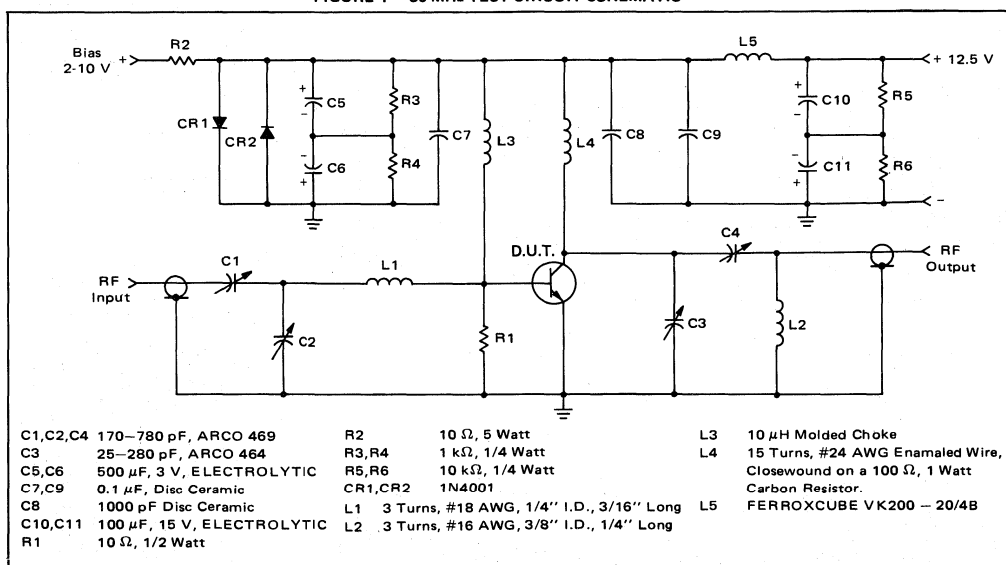
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.0 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $V_{BE} = 0$, $T_C = 55^\circ\text{C}$)	I_{CES}	—	—	8.0	mA
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 0.5 \text{ A}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	15	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	70	120	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ⁽¹⁾ ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 12.5 \text{ W (PEP)}$, $I_{CQ} = 100 \text{ mA}$, $f = 30, 30.001 \text{ MHz}$)	G_{pe}	20	—	—	dB
Collector Efficiency ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 12.5 \text{ W (PEP)}$ ($f = 30, 30.001 \text{ MHz}$)	$\eta_{(1)}$ $\eta_{(2)}$	45 40	50 45	—	%
Intermodulation Distortion ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 12.5 \text{ W (PEP)}$, $I_{CQ} = 100 \text{ mA}$, $f = 30, 30.001 \text{ MHz}$)	IMD	—	—	-30	dB
Series Equivalent Input Impedance ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 12.5 \text{ W (PEP)}$, $I_{CQ} = 100 \text{ mA}$, $f = 30, 30.001 \text{ MHz}$)	Z_{in}	—	2.50-j2.20	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 12.5 \text{ W (PEP)}$, $I_{CQ} = 100 \text{ mA}$, $f = 30, 30.001 \text{ MHz}$)	Z_{out}	—	4.80-j3.00	—	Ohms

FIGURE 1 – 30 MHz TEST CIRCUIT SCHEMATIC



MRF448

The RF Line

NPN SILICON RF POWER TRANSISTOR

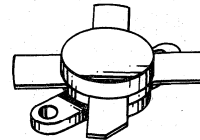
... designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics
Output Power = 250 W
Minimum Gain = 12 dB
Efficiency = 45%
- Intermodulation Distortion @ 250 W (PEP) —
IMD = -30 dB (Max)
- 100% Tested for Load Mismatch at all Phase Angles with
3:1 VSWR

250 W — 30 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



MAXIMUM RATINGS

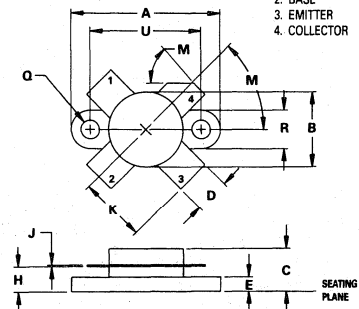
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Withstand Current — 10 s	—	20	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	400 1.67	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	$^\circ\text{C/W}$

(1) P_D is a measurement reflecting short term maximum condition. See θ_{JA} curve for operating conditions.

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



NOTES:
1. DIMENSIONING AND TOLERANCING PER
ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	50	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	100	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 5.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	30	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	350	450	pF
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FUNCTIONAL TEST

Common-Emitter Amplifier Power Gain ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 250\text{ W CW}$, $f = 30\text{ MHz}$, $I_{CQ} = 250\text{ mA}$)	G_{PE}	12	14	—	dB
Collector Efficiency ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 250\text{ W}$, $f = 30\text{ MHz}$, $I_{CQ} = 250\text{ mA}$)	η	—	45 65	—	% (PEP) % (CW)
Intermodulation Distortion (1) ($V_{CE} = 50\text{ Vdc}$, $P_{out} = 250\text{ W (PEP)}$, $I_{CQ} = 250\text{ mA}$, $f = 30\text{ MHz}$)	IMD	—	-33	-30	dB
Electrical Ruggedness ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 250\text{ W CW}$, $f = 30\text{ MHz}$, VSWR 3:1 at all Phase Angles)	No Degradation in Output Power				

(1) To Mil Std 1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

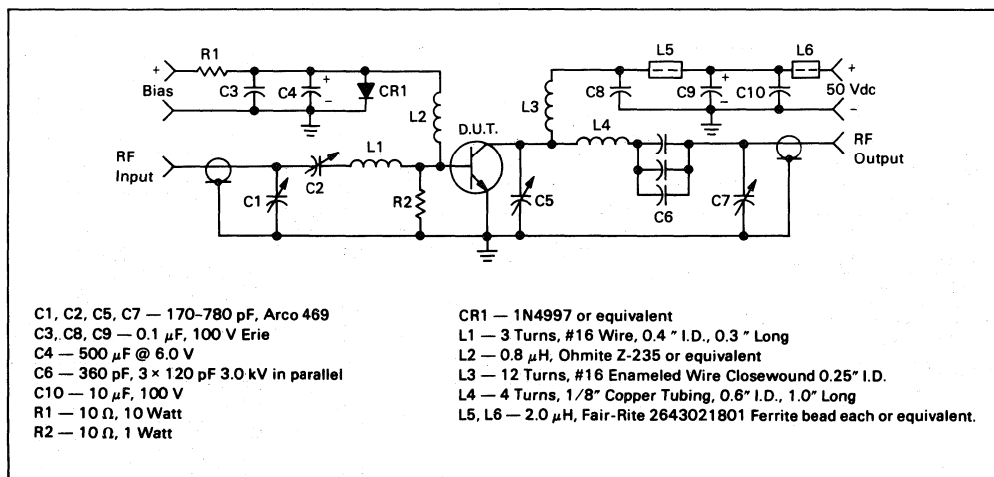
FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC

FIGURE 2 — OUTPUT POWER versus INPUT POWER

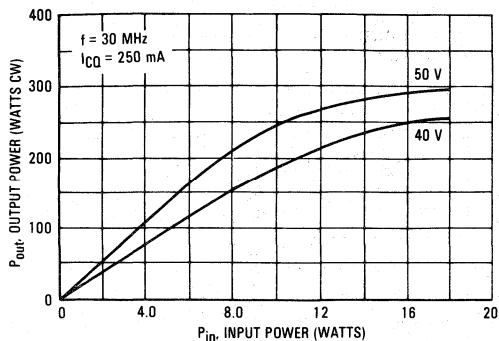


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

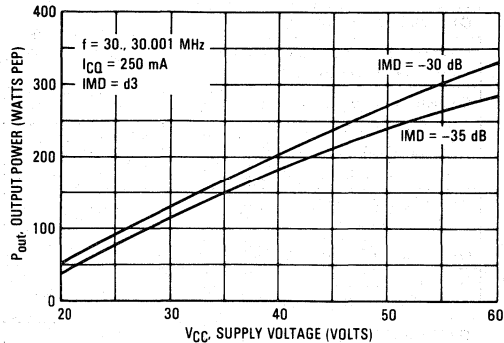


FIGURE 4 — POWER GAIN versus FREQUENCY

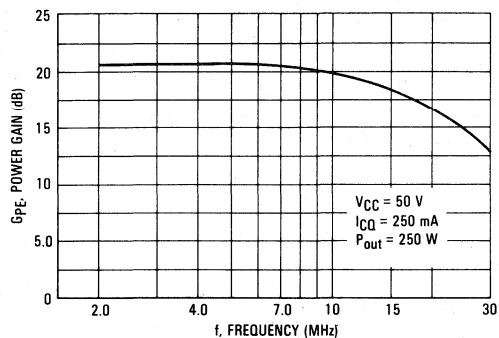
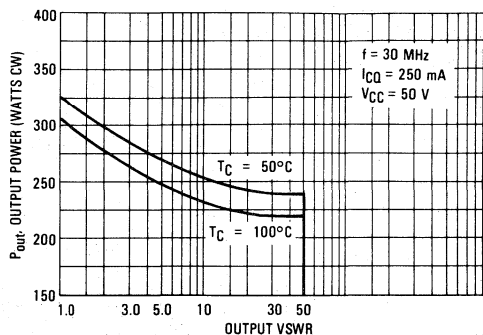
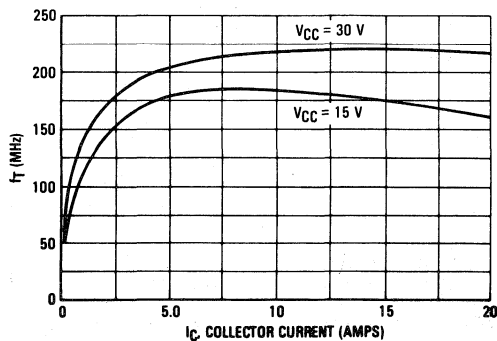
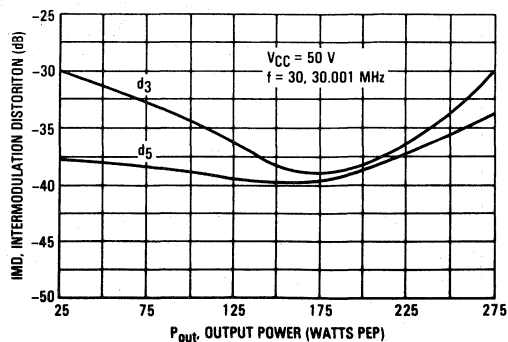
FIGURE 5 — RF SOAR (CLASS AB)
 P_{out} versus OUTPUT VSWRFIGURE 6 — f_T versus COLLECTOR CURRENTFIGURE 7 — IMD versus P_{out} 

FIGURE 8 — OUTPUT RESISTANCE AND CAPACITANCE versus FREQUENCY

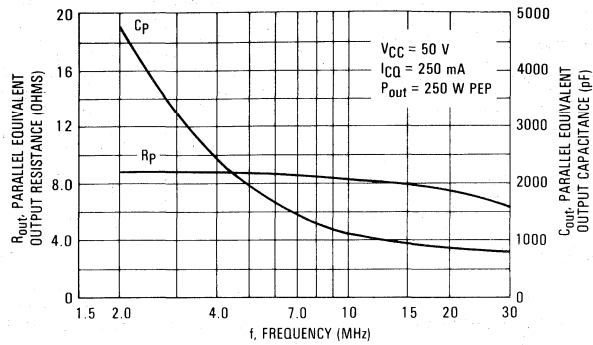
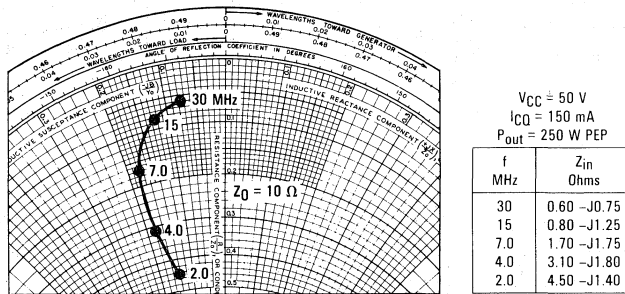


FIGURE 9 — SERIES EQUIVALENT IMPEDANCE



MRF449A

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for power amplifier application in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
Output Power = 30 Watts
Minimum Gain = 12 dB
Efficiency = 50%

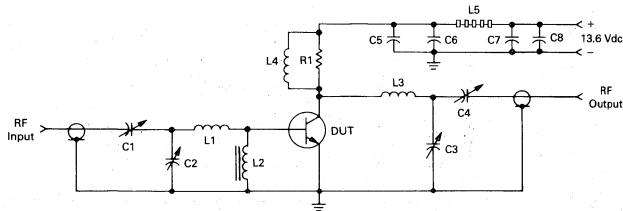
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	60 343	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.9	$^\circ\text{C/W}$

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC

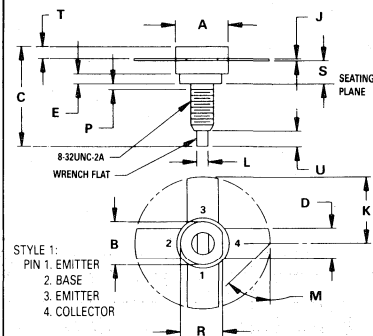
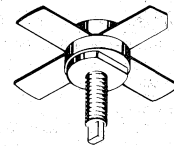


- C1 — 14–150 pF, ARCO 424
C2, C3, C4 — 170–780 pF, ARCO 469
C5, C8 — ERIE 0.1 μF @ 100 V RED CAPS
C6 — 1000 pF UNELCO, 350 Vdc
C7 — 10 μF , 35 Vdc
R1 — 100 Ω , 2.0 W Carbon
L1 — 0.15 μH Molded Choke MILLER
L2 — FERROXCUBE, VK200-20-4B
L3 — 3 Turns, #14 Bare Tinned Wire, 0.3" (0.79) I.D. x 0.38" (0.97) Long
L4 — 9 Turns, #20 Enamel Wire, Close Wound on R1
L5 — FERROXCUBE #56-570-65/3B, 5 Ferrite Beads, on 1" Long #20 Wire
Input/Output Connectors — Type N
Board — Glass Teflon Mounted on a 4" x 4" x 2" SEEZAK Box

30 W — 30 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

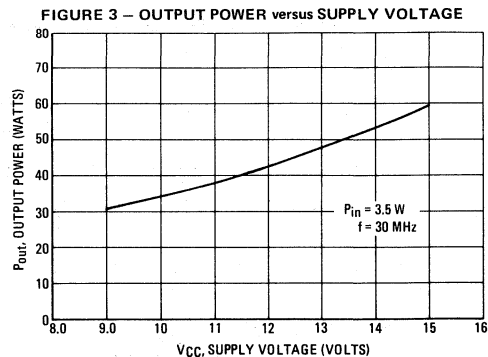
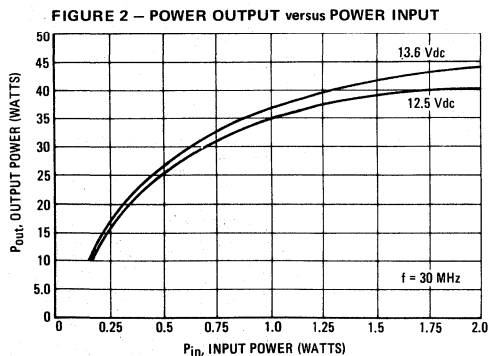
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	40	50	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	140	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 13.6\text{ Vdc}$, $P_{out} = 30\text{ W}$, $I_{C(max)} = 4.0\text{ Adc}$, $f = 30\text{ MHz}$)	G_{pE}	12	14	—	dB
Collector Efficiency ($V_{CC} = 13.6\text{ Vdc}$, $P_{out} = 30\text{ W}$, $I_{C(max)} = 4.0\text{ Adc}$, $f = 30\text{ MHz}$)	η	50	—	—	%
Series Equivalent Input Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 30\text{ MHz}$)	Z_{in}	—	$2.13-j1.15$	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 30\text{ MHz}$)	Z_{out}	—	$2.47-j0.37$	—	Ohms



The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
Output Power = 50 Watts
Minimum Gain = 11 dB
Efficiency = 50%

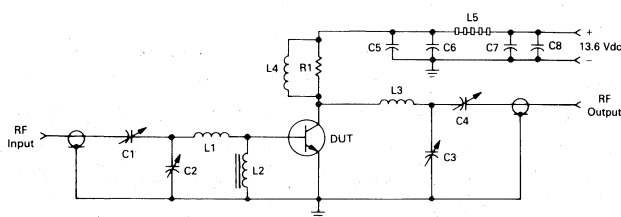
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	— Vdc
Collector Current — Continuous	I_C	7.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	115 0.66	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.53	$^\circ\text{C}/\text{W}$

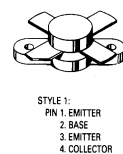
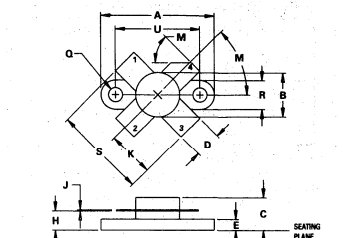
FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



- C1 — 14–150 pF, ARCO 424
C2, C3, C4 — 170–780 pF, ARCO 469
C5, C8 — ERIE 0.1 μF @ 100 V RED CAPS
C6 — 1000 pF UNELCO, 350 Vdc
C7 — 10 μF , 35 Vdc
R1 — 100 Ω , 2.0 W Carbon
L1 — 0.15 μH Molded Choke MILLER
L2 — FERROXCUBE, VK200-20-4B
L3 — 3 Turns, #14 Bare Tinned Wire, 0.3" (0.79) I.D. x 0.38" (0.97) Long
L4 — 9 Turns, #20 Enamel Wire, Close Wound on R1
L5 — FERROXCUBE #56-570-65/3B, 5 Ferrite Beads, on 1" Long #20 Wire
Input/Output Connectors — Type N
Board — Glass Teflon Mounted on a 4" x 4" x 2" SEEZAK Box

MRF450 MRF450A

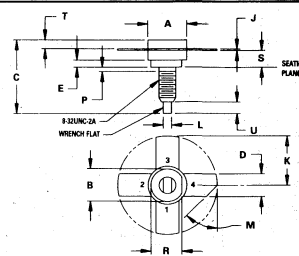
50 W — 30 MHz RF POWER TRANSISTORS NPN SILICON



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	5.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07
MRF450



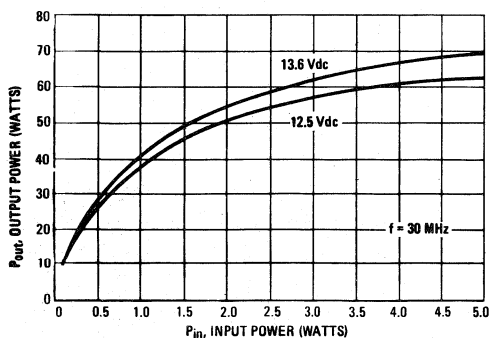
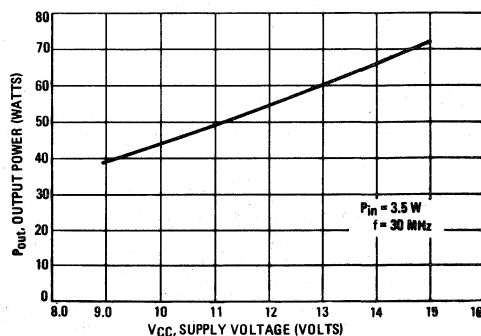
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	9.40	9.90	0.370	0.390
B	8.12	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM	—	45° NOM	—
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.179
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09
MRF450A

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	200	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 13.6\text{ Vdc}$, $P_{out} = 50\text{ W}$, $I_C(\text{max}) = 6.13\text{ A}$, $f = 30\text{ MHz}$)	G_{PE}	11	15	—	dB
Collector Efficiency ($V_{CC} = 13.6\text{ Vdc}$, $P_{out} = 50\text{ W}$, $I_C(\text{max}) = 6.13\text{ A}$, $f = 30\text{ MHz}$)	η	50	—	—	%
Series Equivalent Input Impedance ($V_{CC} = 13.6\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 30\text{ MHz}$)	Z_{in}	—	$1.56-j.89$	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 13.6\text{ Vdc}$, $P_{out} = 50\text{ W}$, $f = 30\text{ MHz}$)	Z_{out}	—	$174-j.50$	—	Ohms

FIGURE 2 — INPUT POWER versus OUTPUT POWER**FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE**

MRF454

The RF Line

NPN SILICON RF POWER TRANSISTOR

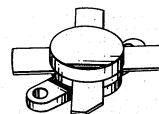
... designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
Output Power = 80 Watts
Minimum Gain = 12 dB
Efficiency = 50%

80 W — 30 MHz

**RF POWER
TRANSISTOR**

NPN SILICON

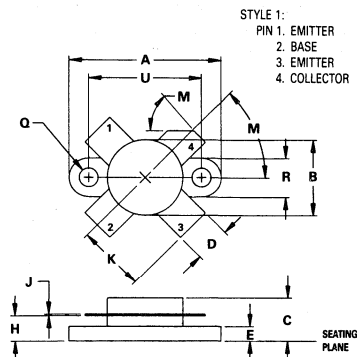


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	250 1.43	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	$^\circ\text{C/W}$



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

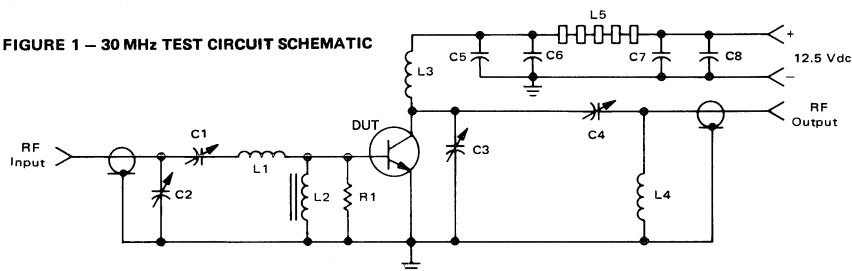
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45°	NOM	45°	NOM
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ A}$, $V_{CE} = 5.0\text{ V}$)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	250	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 30\text{ MHz}$)	G_{pe}	12	—	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 30\text{ MHz}$)	η	50	—	—	%
Series Equivalent Input Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 30\text{ MHz}$)	Z_{in}	—	.938-j.341	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 30\text{ MHz}$)	Z_{out}	—	1.16-j.201	—	Ohms
Parallel Equivalent Input Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 30\text{ MHz}$)	—	—	1.06 Ω 1817 pF	—	—
Parallel Equivalent Output Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 30\text{ MHz}$)	—	—	1.19 Ω 777 pF	—	—

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C4 ARCO 469
C3 ARCO 466
C5 1000 pF, UNELCO
C6, C7 0.1 μF Disk Ceramic
C8 1000 $\mu\text{F}/15\text{ V}$ Electrolytic
R1 10 Ohm/1 Watt, Carbon

L1 3 Turns, #18 AWG, 5/16" I.D., 5/16" Long
L2 VK200 - 20/4B, FERROXCUBE
L3 12 Turns, #18 AWG Enamelled Wire, 1/4" I.D.,
Close Wound
L4 3 Turns 1/8" O.D. Copper Tubing, 3/8" I.D.,
3/4" Long
L5 7 FERRITE Beads, FERROXCUBE #56-590-65/3B

FIGURE 2 — OUTPUT POWER versus INPUT POWER

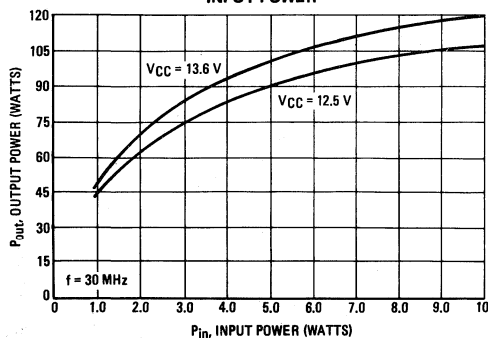
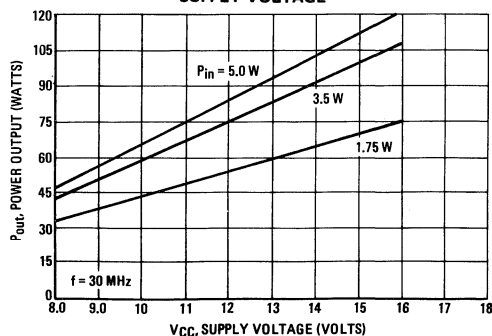


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE



MRF455
MRF455A

The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
Output Power = 60 Watts
Minimum Gain = 13 dB
Efficiency = 55%

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE}	18	Vdc
Collector-Emitter Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$	P_D	175	Watts
Derate above 25°C		1.0	W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

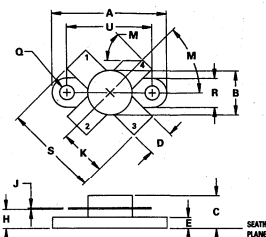
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	$^\circ\text{C/W}$

MATCHING PROCEDURE

In the push-pull circuit configuration it is preferred that the transistors are used as matched pairs to obtain optimum performance.

The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.

60 W — 30 MHz
RF POWER TRANSISTORS
NPN SILICON



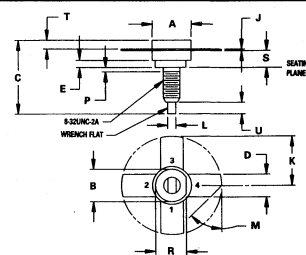
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.



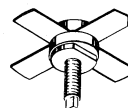
STYLE 1:
PIN 1: EMITTER
2: BASE
3: EMITTER
4: COLLECTOR

CASE 211-07
MRF455

DIM	MIN	MAX	MIN	MAX
A	28.25	25.14	0.950	0.990
B	5.40	5.90	0.210	0.230
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
F	3.91	4.57	0.150	0.180
G	0.11	0.15	0.004	0.006
H	10.04	10.28	0.395	0.405
J	40°	50°	40°	50°
K	2.88	3.30	0.113	0.130
L	6.23	6.47	0.245	0.255
M	20.07	20.57	0.790	0.810
N	18.29	18.54	0.720	0.730



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.



STYLE 1:
PIN 1: EMITTER
2: BASE
3: EMITTER
4: COLLECTOR

CASE 145A-09

DIM	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
F	0.08	0.18	0.003	0.007
G	12.45	—	0.490	—
H	1.40	1.78	0.055	0.070
J	45° NOM	45° NOM	—	—
K	—	1.27	—	0.050
L	7.59	7.80	0.299	0.307
M	4.01	4.52	0.158	0.178
N	2.11	2.54	0.083	0.100
O	2.48	3.35	0.098	0.132

ELECTRICAL CHARACTERISTICS (TC = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	—	250	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 30 \text{ MHz}$)	G_{pe}	13	—	—	dB
Collector Efficiency ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 30 \text{ MHz}$)	η	55	—	—	%
Series Equivalent Input Impedance ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 30 \text{ MHz}$)	Z_{in}	—	$1.66-j.844$	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 30 \text{ MHz}$)	Z_{out}	—	$1.73-j.188$	—	Ohms
Parallel Equivalent Input Impedance ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 30 \text{ MHz}$)	Z_{in}	—	$2.09/1030$	—	Ω/pF
Parallel Equivalent Output Impedance ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 30 \text{ MHz}$)	Z_{out}	—	$1.75/330$	—	Ω/pF

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC

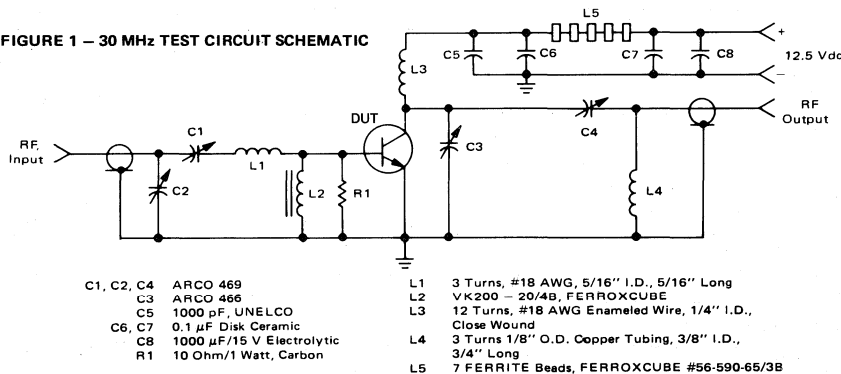


FIGURE 2 — OUTPUT POWER versus INPUT POWER

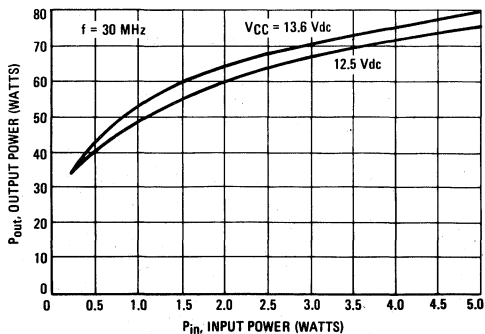
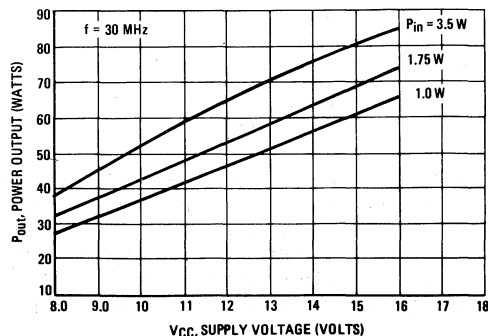


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE



MRF458

The RF Line

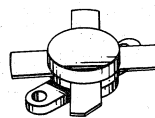
NPN SILICON RF POWER TRANSISTOR

... designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
 Output Power = 80 Watts
 Minimum Gain = 12 dB
 Efficiency = 50%
- Capable of Withstanding 30:1 Load VSWR @ Rated P_{out} and V_{CC}

80 W — 30 MHz

**RF POWER
 TRANSISTOR**
 NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	175	Watts
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

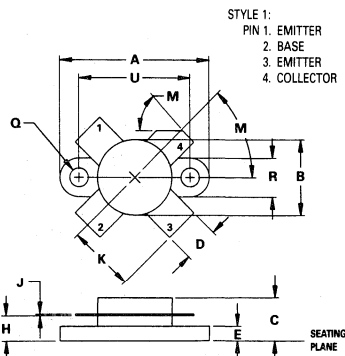
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	$^\circ\text{C/W}$

MATCHING PROCEDURE

In the push-pull circuit configuration, it is preferred that the transistors are used as matched pairs to obtain optimum performance.

The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

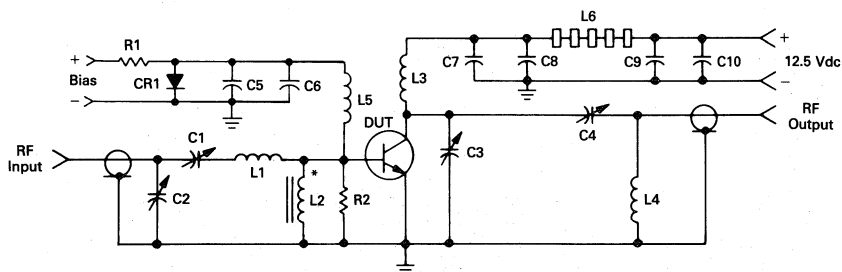
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	300	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 30\text{ MHz}$)	G_{pE}	12	—	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 80\text{ W}$, $f = 30\text{ MHz}$)	η	50	—	—	%
Intermodulation Distortion ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 70\text{ W PEP}$, $f = 30, 30.001\text{ MHz}$)	IMD_3 IMD_5	— —	-32 -35	— —	dB

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C4 — ARCO 469
 C3 — ARCO 466
 C5 — ERIE 0.1 μF , 100 V
 C6 — 500 μF , 15 V Electrolytic
 C7 — 1000 pF, UNELCO
 C8, C9 — 0.1 μF Disk Ceramic
 C10 — 100 μF , 15 V Electrolytic
 CR1 — 1N4997
 R1 — 10 Ω , 25 Watt Wirewound
 R2 — 10 Ohm, 1 Watt, Carbon

L1 — 3 Turns #18 AWG, 5/16" I.D.,
 5/16" Long
 L2, L5 — VK200 — 20/4B, FERROXCUBE
 L3 — 12 Turns, #18 AWG Enameled Wire,
 1/4" I.D., Close Wound
 L4 — 3 Turns 1/8" O.D. Copper Tubing,
 3/8" I.D., 3/4" Long
 L6 — 7 FERRITE Beads, FERROXCUBE
 #56-590-65/3B

*NOTE: For Class C operation bias network (R1, R2, CR1, C5, C6, L5) is not used.
 For Class AB operation L2 is not used.

TYPICAL PERFORMANCE CURVES

FIGURE 2 — POWER GAIN versus FREQUENCY

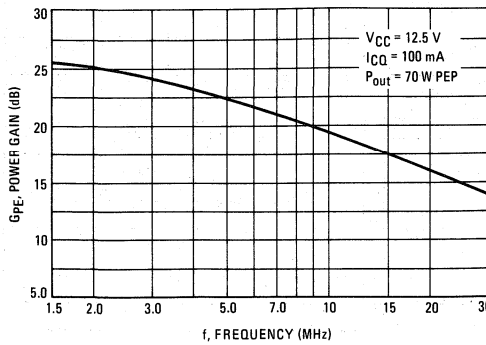


FIGURE 3 — OUTPUT RESISTANCE versus FREQUENCY

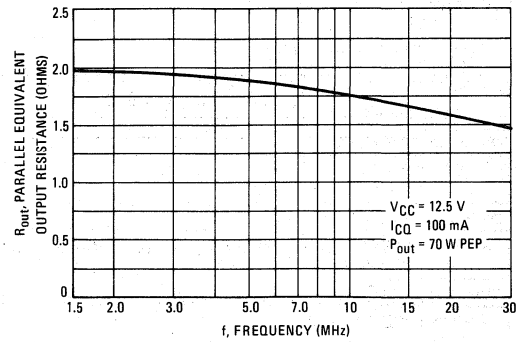


FIGURE 4 — OUTPUT CAPACITANCE versus FREQUENCY

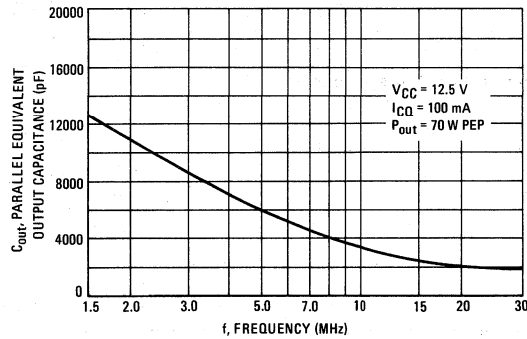
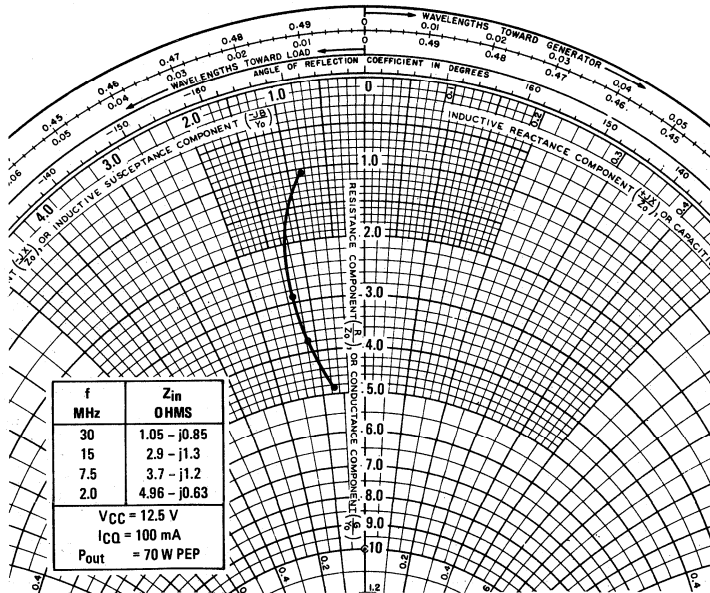


FIGURE 5 — SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



MRF460

The RF Line

NPN SILICON RF POWER TRANSISTOR

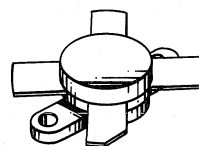
... designed primarily for applications as a high-power linear amplifier from 2.0 to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics —
Output Power = 40 W (PEP)
Minimum Gain = 12 dB
Efficiency = 40%
- Intermodulation Distortion at Rated Power Output —
IMD = -30 dB (Max)
- Isothermal-Resistor Design Results in Rugged Device
- Replacement for 2N6368

40 W (PEP) — 30 MHz

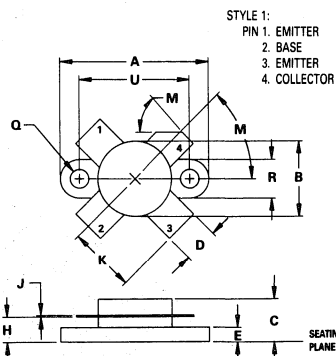
**RF POWER
TRANSISTOR**

NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	175 1.0	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

*ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 12.5\text{ Vdc}$, $V_{BE} = 0$, $T_C = +55^\circ\text{C}$)	I_{CES}	—	—	10	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 1.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	40	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	300	350	pF
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FUNCTIONAL TEST

Common-Emitter Amplifier Power Gain (Figure 1) ($P_{out} = 40\text{ W (PEP)}$, $I_C = 4.7\text{ Adc Max}$, $V_{CC} = 12.5\text{ Vdc}$, $I_{CQ} = 50\text{ mAdc}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$)	G_{PE}	12	15	—	dB
Intermodulation Distortion Ratio (Figure 1) ($P_{out} = 40\text{ W (PEP)}$, $I_C = 4.7\text{ Adc Max}$, $V_{CC} = 12.5\text{ Vdc}$, $I_{CQ} = 50\text{ mAdc}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$)	IMD	—	-35	-30	dB
Collector Efficiency (Figure 1) ($P_{out} = 40\text{ W (PEP)}$, $I_C = 4.7\text{ Adc Max}$, $V_{CC} = 12.5\text{ Vdc}$, $I_{CQ} = 50\text{ mAdc}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$)	η	40	45	—	%

*Indicates JEDEC Registered Data.

FIGURE 1 — 30 MHz TEST CIRCUIT

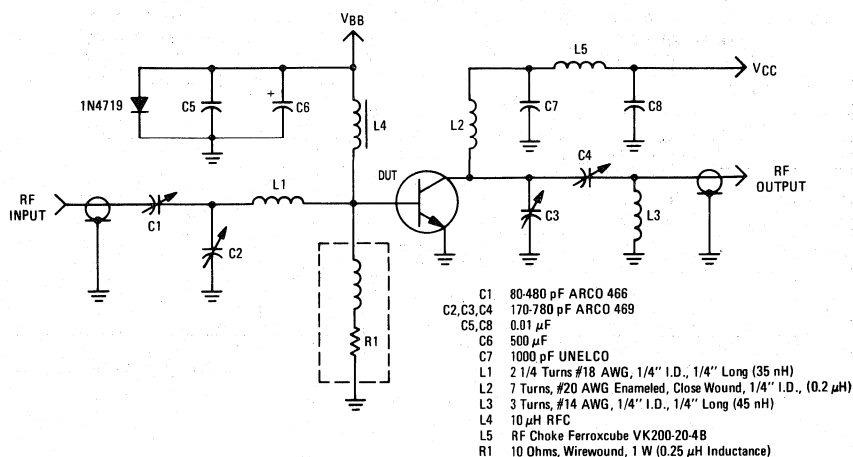


FIGURE 2 — OUTPUT POWER versus INPUT POWER

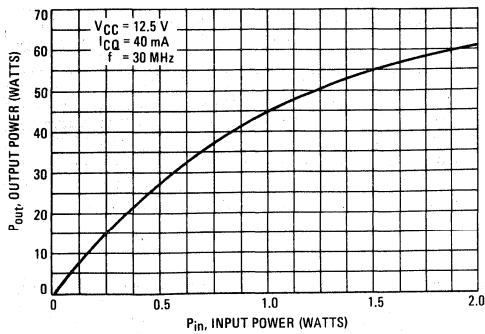


FIGURE 3 — POWER GAIN versus FREQUENCY

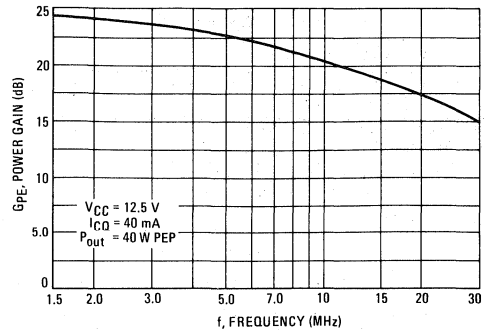


FIGURE 4 — INTERMODULATION DISTORTION versus OUTPUT POWER

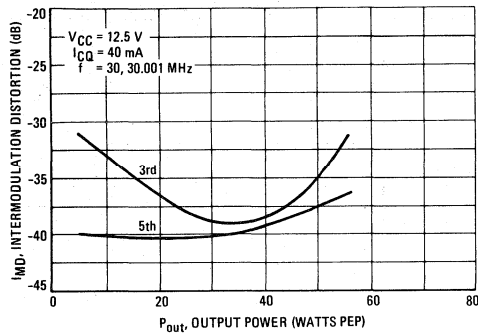


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE

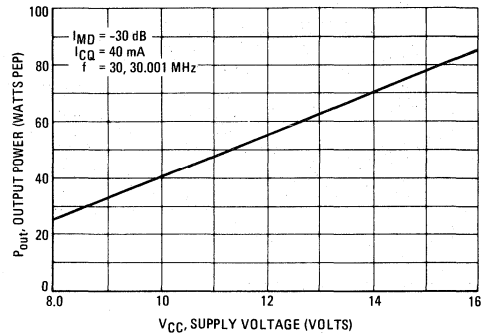


FIGURE 6 — OUTPUT RESISTANCE versus FREQUENCY

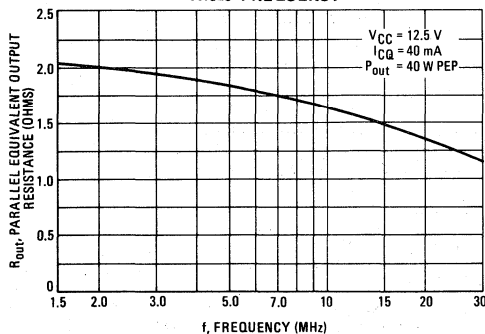


FIGURE 7 — OUTPUT CAPACITANCE versus FREQUENCY

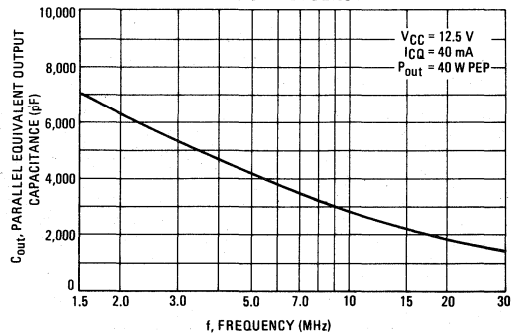
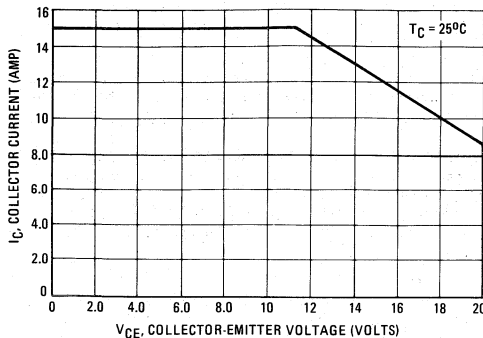


FIGURE 8 — DC SAFE OPERATING AREA

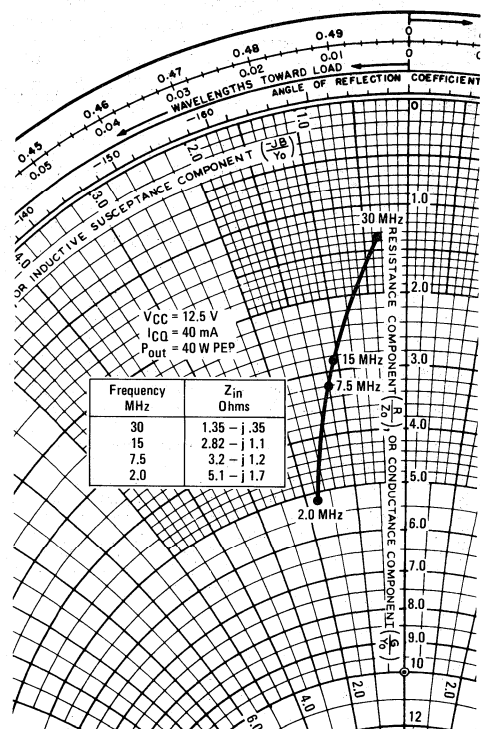


MATCHING PROCEDURE

In the push-pull circuit configuration two device parameters are critical for optimum circuit performance. These parameters are $V_{BE(on)}$ and h_{FE} . Both parameters can be guaranteed by measuring I_{CQ} of the devices and selecting pairs with a $\Delta I_{CQ} \leq 10$ mAdc.

Actual I_{CQ} matching is performed in the MRF460 test circuit with a V_{CE} equal to 28 Volts. The base bias supply is adjusted to set I_{CQ} equal to 40 mAdc using a reference standard MRF460. The production MRF460s are tested and categorized in ranges of 10 mAdc. Finally, the devices are stocked as pairs with a guaranteed $\Delta I_{CQ} \leq 10$ mAdc.

FIGURE 9 — SERIES EQUIVALENT IMPEDANCE



APPLICATIONS INFORMATION

The MRF460 transistor is designed for linear power amplifier operation in the HF region (2 to 30 MHz). It features guaranteed linear amplifier performance rather than the conventional performance demonstrated in a class C* amplifier.

Class C operation is inherently non-linear, but in many power amplifier applications non-linear operation does not present major problems. With a single frequency driving signal, the only spurious signals generated are harmonics and these can be suppressed in the amplifier tuned networks and output filter.

For single sideband (SSB), low level amplitude modulation (AM), and other types of complex signals, class C operation is generally not satisfactory. For instance, when a signal contains multiple frequencies at close spacings, odd-order non-linearities will generate spurious outputs which are within the passband of the tuned circuits and filters; therefore, the spurious outputs are not suppressed before they reach the antenna or other load. As a result,

*"Class C", as used here refers to operation with the no signal conditions $I_C = 0$, and $V_{BE} = 0$, and a theoretical conduction angle of less than 180° even though the actual conduction angle may be more than 180° .

such complex signals require linear amplification if the amplified signal is to be free of spurious outputs.

A detailed analysis of spurious signals generated by non-linearities and linearity requirements of various applications is described in Chapter 12 of Reference 1.

The following discussion concerns itself with a detailed description of the MRF460 characterization curves and general information on solid-state linear power amplifier design.

The Two-Tone Test

The MRF460 functional test specifications consist of a linear power amplifier test with guaranteed limits on power output, gain, efficiency, and intermodulation distortion (IMD) output levels. A two-tone test signal is used with the test amplifier as shown in Figure 1.

The two-tone test is one of many methods commonly used for testing linear amplifier performance. This test involves driving the amplifier with two RF signals, of equal amplitude, separated in frequency from each other by approximately 1 kHz.

When a two-tone test signal consisting of frequencies f_1 and f_2 is passed through a non-linear amplifier, odd order non-linearities generate spurious signals near the desired carrier. The level of these spurious signals provides a measure of the degree of non-linearity of the amplifier. This type of non-linearity is called intermodulation distortion (IMD). The spurious signals generated by IMD are further classified according to the exponential order of the amplifier non-linearity, i.e., 3rd order IMD products, 5th order IMD products, etc. The 3rd and 5th order IMD products are usually the most significant encountered with linear power amplifiers. Data on both 3rd and 5th order IMD are included in the MRF460 characterization.

Third order IMD generates spurious signals near the operating frequency at frequencies $2f_1 - f_2$ and $2f_2 - f_1$; and 5th order IMD spurious are at frequencies $3f_1 - 2f_2$ and $3f_2 - 2f_1$.

Specifications and Characterization

The two-tone functional amplifier test is performed in a manner identical to the conventional class C functional test with two exceptions: a two-frequency signal is used in place of a single frequency, and amplifier linearity is added to the items tested and specified.

The functional test procedure for the MRF460 requires driving the test amplifier with a two-frequency signal and measuring power output, gain, efficiency, and linearity.

Power output, gain and efficiency measurement methods are the same for both linear and class C amplifier.

Since a multiple frequency test signal has an instantaneous power level which varies with time, power levels are normally expressed in peak envelope power (PEP). This is the average power level of the envelope at its greatest amplitude point.

When the test signal consists of multiple signals with equal amplitudes and different frequencies, the relationship of average power and PEP is given by the following expression:

$$\text{Average power} = \frac{\text{PEP}}{N}$$

where N = the number of input frequencies.

Therefore, when measuring the power level of a standard two-tone test signal, a true average reading power meter will indicate 1/2 the PEP of the signal.

Linearity is tested by measuring the amplitudes of the 3rd and 5th order IMD products. The ratio of one of the 3rd order products to one of the two desired frequencies is then expressed as a power ratio in decibels (dB). This is repeated for the 5th order products. The smaller of these two ratios (usually the 3rd order) is then included in the electrical characteristics specifications as intermodulation distortion ratio (IMD).

MRF460 Performance Curves

Figures 2 and 3 show typical power output and gain characteristics versus frequency and/or input power. These curves are similar to those found on other RF power transistor data sheets with one exception, a two-frequency test signal was used rather than a single frequency signal.

The curves shown in Figure 4 are unique to transistors characterized for linear power amplifier service and show the typical IMD levels versus power output.

The MRF460 features guaranteed IMD performance at the -30 dB level. However, the designer may desire IMD greater or less than -30 dB for a particular application. Figure 4 provides data on IMD levels that can be expected as a function of output power.

REFERENCES

1. Pappenfus, Bruene, Schoenike, "Single Sideband Principles and Circuits", McGraw-Hill.
2. Hejhall, "Systemizing RF Power Amplifier Design", Motorola Semiconductor Products Inc., Application Note AN-282A.
3. Hejhall, "Solid-State Linear Power Amplifier Design," Motorola Semiconductor Products Inc., Application Note AN-546.

Figure 5 reflects the power output that can be obtained at a fixed IMD ratio for operation with dc supply voltages other than 12.5 Vdc.

Figures 6 and 7 show the large signal impedance characteristics of the MRF460. These are similar to curves shown on other Motorola data sheets except a two-frequency test signal was used rather than a single frequency signal.

It must be stressed that the data shown in Figures 6 and 7 do not represent y , z , h , s , or any standard two-port parameter set. The actual transistor impedance levels during normal operation in a power amplifier are given. For a detailed discussion of RF power transistor large signal impedance, see Reference 2.

Linear Amplifier Design

The following is a discussion of some general design considerations for solid-state linear power amplifiers. While this is not a detailed analysis of linear amplifier design, some general guidelines are provided.

The major difference between linear power amplifiers and class C power amplifiers is in the dc bias circuitry. As stated in the introduction, class C operation usually involves a collector dc supply as the only bias voltage with $V_E = V_B = 0$. The collector current is zero until the input RF signal turns the transistor "on."

In contrast, a linear amplifier is normally operated with forward bias and some collector current flowing when no signal is present.

The magnitude of no-signal collector current and the bias circuitry may vary with the application. Optimum no-signal collector current for the MRF460 was found to be approximately 50 mA.

The key to bias circuitry for good linearity lies in maintaining the base-emitter dc voltage relatively constant as the RF signal amplitude varies. The inherent nature of a forward-biased RF power transistor is to bias itself "off" with increasing RF drive signal. Therefore, a constant voltage source is required for base voltage.

Temperature effects also complicate the situation, since V_{BE} decreases with increasing temperature.

A simple solution to the bias problem involves the use of a forward-biased diode mounted on the transistor heat sink for thermal coupling to the transistor. A sample of this technique is shown in the test circuit of Figure 1. The reader is referred to reference 3 for a detailed description of the operation of this bias circuit. It is also possible to use complex active circuitry for biasing, and some rather exotic schemes have been developed to provide the same results.

Another important consideration is the collector-output network. Normally, a network with low impedance to ground for harmonics provides better linearity than a network with high harmonic impedances; therefore, some experimentation with network configuration is in order. Proper impedance matching remains the primary factor in both input and output network design. Further, it must also be stressed that the collector load impedance should be designed for the PEP, not the average power output. See Chapter 13 of Reference 1 for a detailed discussion of network design considerations.

Feedback may also be employed to improve linearity and may take the form of either neutralization or negative RF feedback. The possibilities here are limited only by the designer's imagination. Of course, negative RF feedback involves a decrease in gain to improve linearity.

The RF Line

NPN SILICON RF POWER TRANSISTORS

... designed primarily for applications as a high-power linear amplifier from 2.0 to 30 MHz, in single sideband mobile, marine and base station equipment.

- Specified 28 Volt, 30 MHz Characteristics —
Output Power = 80 W (PEP)
Minimum Gain = 15 dB
Efficiency = 40%
Intermodulation Distortion = -32 dB (Max)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	250 1.4	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	$^\circ\text{C/W}$
Stud Torque (1)	—	8.5	In. Lb

(1) Case 145A-10 — For Repeated Assembly Use 11 In. Lb.

MATCHING PROCEDURE

In the push-pull circuit configuration it is preferred that the transistors are used as matched pairs to obtain optimum performance.

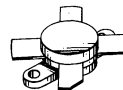
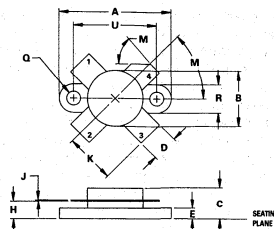
The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.

MRF464 MRF464A

80 W (PEP) — 30 MHz

RF POWER TRANSISTORS

NPN SILICON

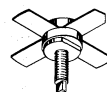
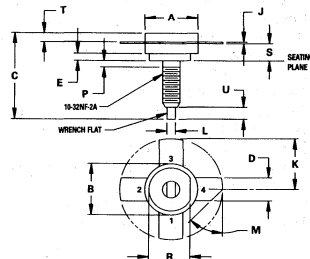


STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 211-11
MRF464

NOTES:
1. DIMENSIONING AND TOLERANCING PER
ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	24.29	25.14	0.959	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
F	3.66	4.52	0.144	0.178
G	0.68	0.17	0.003	0.007
H	11.05	—	0.435	—
J	—	—	—	—
K	—	—	—	—
L	—	—	—	—
M	—	—	—	—
N	—	—	—	—
P	—	—	—	—
Q	—	—	—	—
R	—	—	—	—
S	—	—	—	—
T	—	—	—	—
U	—	—	—	—



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 145A-10
MRF464A

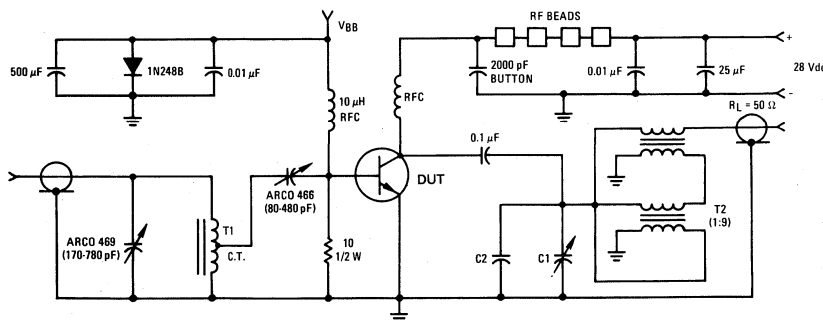
NOTES:
1. DIMENSIONING AND TOLERANCING
PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	12.45	12.95	0.490	0.510
B	10.54	10.80	0.415	0.425
C	19.08	22.73	0.775	0.895
D	5.46	5.97	0.215	0.235
E	1.83	—	0.072	—
F	0.08	0.18	0.003	0.007
G	—	—	—	—
H	—	—	—	—
J	—	—	—	—
K	—	—	—	—
L	—	—	—	—
M	—	—	—	—
N	—	—	—	—
P	—	—	—	—
Q	—	—	—	—
R	—	—	—	—
S	—	—	—	—
T	—	—	—	—
U	—	—	—	—

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 28\text{ Vdc}$, $V_{BE} = 0$, $T_C = +55^\circ\text{C}$)	I_{CES}	—	10	mA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 0.5\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	—
DYNAMIC CHARACTERISTICS				
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	200	pF
FUNCTIONAL TEST				
Common-Emitter Amplifier Power Gain (Figure 1) ($P_{out} = 80\text{ W (PEP)}$, $I_C = 3.6\text{ A (Max)}$, $V_{CC} = 28\text{ Vdc}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$)	G_{pE}	15	—	dB
Intermodulation Distortion Ratio (Figure 1) ($P_{out} = 80\text{ W (PEP)}$, $I_C = 3.6\text{ A (Max)}$, $V_{CC} = 28\text{ Vdc}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$)	IMD	—	-32	dB
Collector Efficiency ($P_{out} = 80\text{ W (PEP)}$, $I_C = 3.6\text{ A (Max)}$, $V_{CC} = 28\text{ Vdc}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$)	η	40	—	%

FIGURE 1—30 MHz TEST CIRCUIT



RFC: 20 TURNS #12 AWG ENAMELED WIRE CLOSE WOUND IN 2 LAYERS, 1/4" I.D.
CORE CENTER TAPPED.

T1: 20 TURNS #24 AWG WIRE WOUND ON MICRO-METALS T37-7 TOROID
CORE CENTER TAPPED.
T2: 1:9 XFMR; 6 TURNS OF 2 TWISTED PAIRS OF #28 AWG ENAMELED WIRE.
(8 CRESTS PER INCH) BIFILAR WOUND ON EACH OF 2 SEPARATE BALUN CORES.
(Stackpole #57-1503, No. 14 Material) Interconnected as shown
RF BEADS: FERROXCUBE #56-590-65/38

V_{BB} adjusted for $I_{CQ} = 40\text{ mA}$ ($I_{CQ} = \text{Quiescent Collector Current}$)

C1 — 170-180 pF ARCO 469 or Equiv.

C2 — 330 pF

FIGURE 2 – OUTPUT POWER versus INPUT POWER

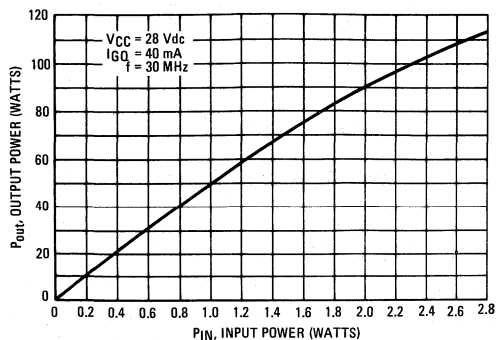


FIGURE 3 – POWER GAIN versus FREQUENCY

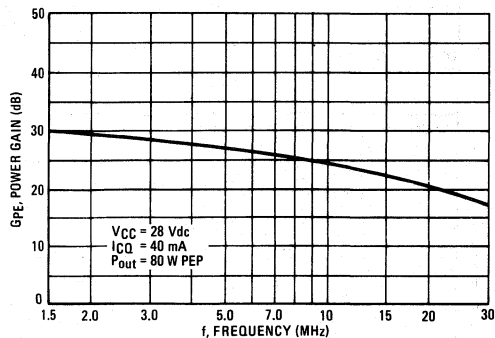


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

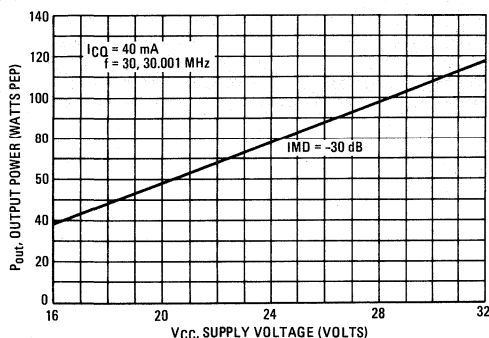


FIGURE 5 – INTERMODULATION DISTORTION versus OUTPUT POWER

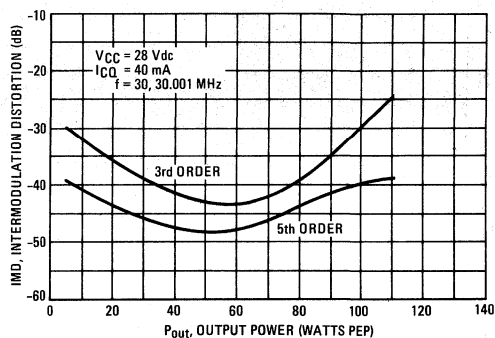


FIGURE 6 – OUTPUT CAPACITANCE versus FREQUENCY

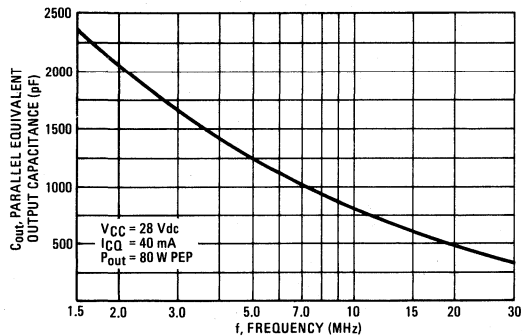


FIGURE 7 – OUTPUT RESISTANCE versus FREQUENCY

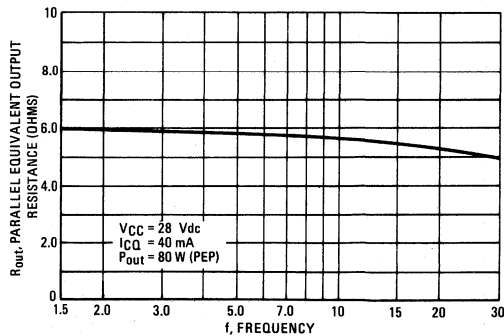


FIGURE 8 — DC SAFE OPERATING AREA

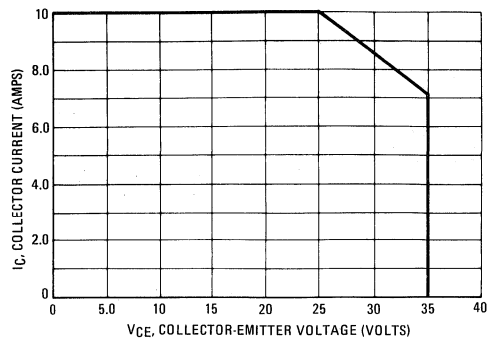
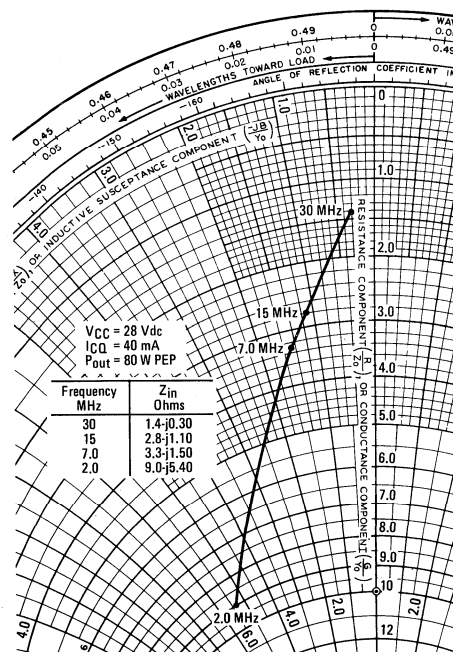


FIGURE 9 — SERIES INPUT IMPEDANCE



MRF466

The RF Line

NPN SILICON RF POWER TRANSISTOR

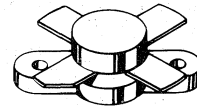
... designed primarily for applications as a high-power amplifier from 2.0 to 30 MHz, in single sideband mobile, marine and base station equipment.

- Specified 28 V, 30 MHz Characteristics —
Output Power = 40 W PEP or CW
Minimum Gain = 15 dB
Efficiency = 40%
Intermodulation Distortion d_3 = -30 dB Max
- Guaranteed Ruggedness
- 2N5941 Replacement

40 W (PEP) 30 MHz

RF POWER TRANSISTOR

NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	6.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	175 1.0	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

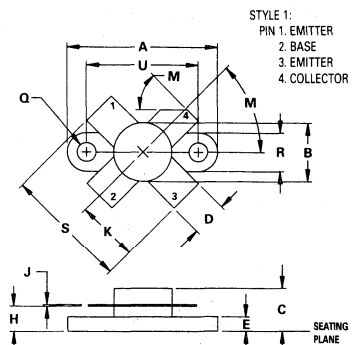
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.0	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MATCHING PROCEDURE

In the push-pull circuit configuration it is preferred that the transistors are used as matched pairs to obtain optimum performance.

The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	5.0	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 0.5\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	40	80	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	125	200	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	G_{pE}	15	19	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	η	40	—	—	%
Intermodulation Distortion (1) ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	$IMD(d_3)$	—	-40	-30	dB
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f = 30\text{ MHz}$, $VSWR = 30:1$ All Angles)	—	No Degradation in Poutput Power			

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT

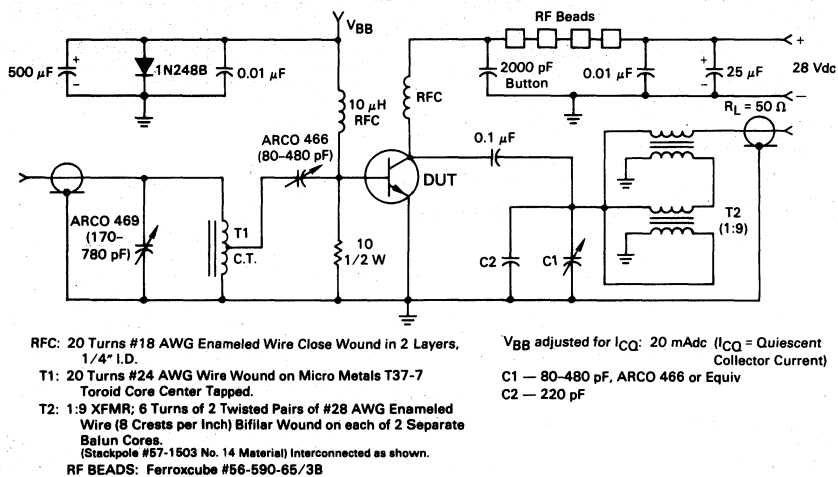


FIGURE 2 — OUTPUT POWER versus INPUT POWER

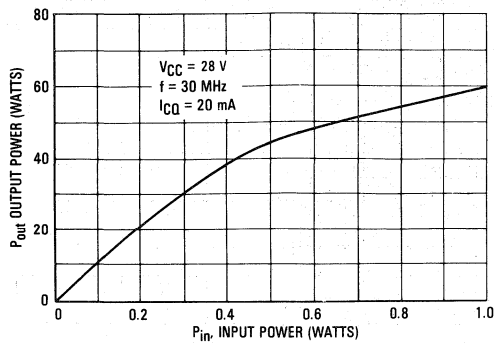


FIGURE 3 — POWER GAIN versus FREQUENCY

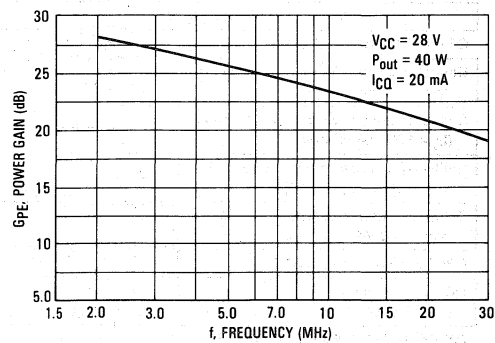


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

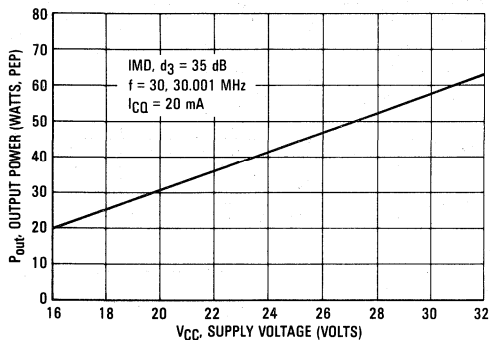


FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER

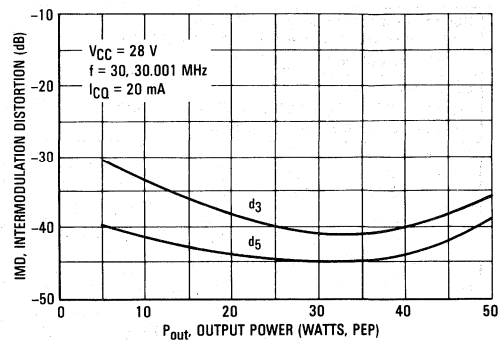


FIGURE 6 — OUTPUT CAPACITANCE versus FREQUENCY

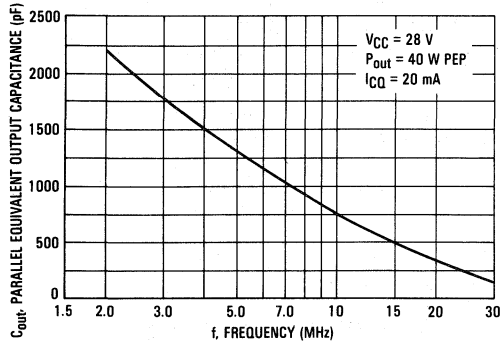
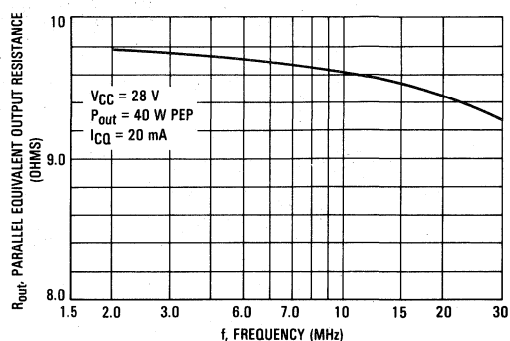


FIGURE 7 — OUTPUT RESISTANCE versus FREQUENCY



2

FIGURE 8 — SAFE OPERATING AREA

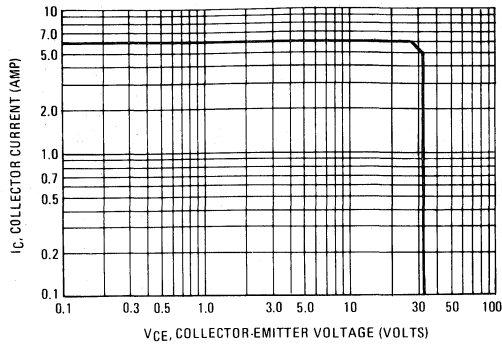
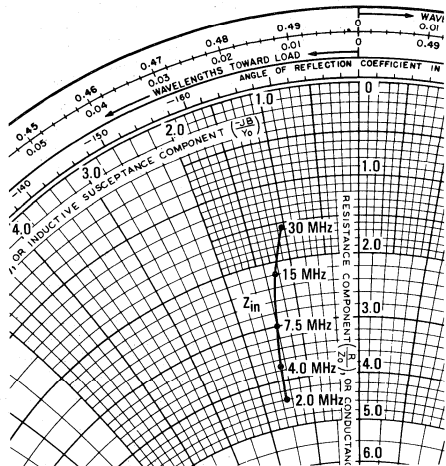


FIGURE 9 — SERIES INPUT IMPEDANCE



$V_{CC} = 28 \text{ V}$
 $I_{CQ} = 20 \text{ mA}$
 $P_{out} = 40 \text{ W (PEP)}$

f MHz	Z_{in} Ohms
30	$1.58 - j1.04$
15	$2.20 - j1.24$
7.5	$3.00 - j1.38$
4.0	$3.70 - j1.45$
2.0	$4.40 - j1.51$

MRF475

The RF Line

NPN SILICON RF POWER TRANSISTOR

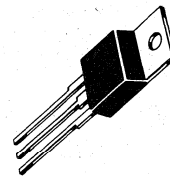
... designed primarily for use in single sideband linear amplifier output applications in citizens band and other communications equipment operating to 30 MHz.

- Characterized for Single Sideband and Large-Signal Amplifier Applications Utilizing Low-Level Modulation
- Specified 13.6 V, 30 MHz Characteristics —
Output Power = 12 W (PEP)
Minimum Efficiency = 40% (SSB)
Output Power = 4.0 W (CW)
Minimum Efficiency = 50% (CW)
Minimum Power Gain = 10 dB (PEP & CW)
- Common Collector Configuration

12 W (PEP) — 12 W (CW) — 30 MHz

RF POWER TRANSISTOR

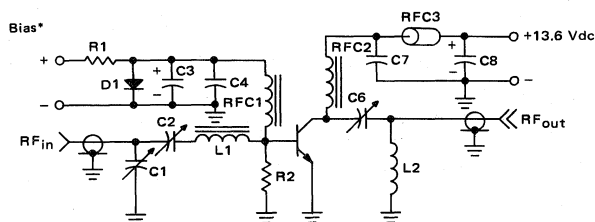
NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ $T_C = 50^\circ\text{C}$ Derate above 50°C	P_D	10 0.1	Watts W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150	$^\circ\text{C}$

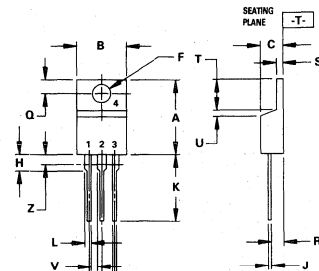
FIGURE 1 — COMMON-EMITTER TEST CIRCUIT



Adjust for $I_{CQ} = 20 \text{ mA}$

- C1, 2, 6 — ARCO 466 Trimmer Capacitors
C3 — 1000 μF , 3.0 Vdc Electrolytic
C4, 7 — 0.1 μF Disc Ceramics
C8 — 100 μF , 15 Vdc Electrolytic
R1 — 10 Ω , 5.0 Watt Resistor
R2 — 10 Ω , 1.0 Watt Resistor
L1 — 2.2 μH Molded Choke
L2 — 4 Turns #18 AWG Wire, 1/2" I.D., 5/16" Long

- RFC1 — 10 μH Molded Choke
RFC2 — 15 Turns #20 AWG Wire on 5.6 k Ω , 1.0 Watt Carbon Resistor
RFC3 — 5 Ferroxcube, #56-590-65/3B, Beads on #18 AWG Wire
D1 — 1N4997



STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.33	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit	
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc	
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	48	—	—	Vdc	
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc	
Collector Cutoff Current ($V_{CB} = 25\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mAdc	
ON CHARACTERISTICS						
DC Current Gain ($I_C = 500\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	30	60	—	—	
DYNAMIC CHARACTERISTICS						
Output Capacitance ($V_{CB} = 13.6\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	125	145	pF	
FUNCTIONAL TESTS (SSB)						
Common-Emitter Amplifier Power Gain ($V_{CC} = 13.6\text{ Vdc}$, $*P_{out} = 12\text{ W}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	G_{PE}	10	12	—	dB	
Collector Efficiency ($V_{CC} = 13.6\text{ Vdc}$, $*P_{out} = 12\text{ W}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	η	40	—	—	%	
Intermodulation Distortion ($V_{CC} = 13.6\text{ Vdc}$, $*P_{out} = 12\text{ W}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	IMD	-30	—	—	%	
FUNCTIONAL TESTS (CW)						
Common-Emitter Amplifier Power Gain ($V_{CC} = 13.6\text{ Vdc}$, $P_{out} = 4.0\text{ W}$, $f = 30\text{ MHz}$)	G_{PE}	10	12	—	dB	
Collector Efficiency ($V_{CC} = 13.6\text{ Vdc}$, $P_{out} = 4.0\text{ W}$, $f = 30\text{ MHz}$)	η	50	—	—	%	
Percentage Up-Modulation (1) (4.0 W Carrier)	—	—	100	—	%	
IMPEDANCE CHARACTERISTICS						
Series Equivalent Input	$V_{CC} = 13.6\text{ Vdc}$ $P_O = 12\text{ W (PEP)}$ $f = 30\text{ MHz}$, $I_{CQ} = 20\text{ mA}$	Z_{in}	—	4.5-j2.4	—	Ohms
Series Equivalent Output		Z_{out}	—	5.1-j3.2	—	Ohms
Parallel Equivalent Input		Z_{in}	—	5.8/10.9	—	Ω/pF
Parallel Equivalent Output		Z_{out}	—	7.1/11.3	—	Ω/pF

*PEP

(1) Percentage Up-Modulation is measured in the test circuit (Figure 1) by setting the Carrier Power (P_C) to 4.0 Watts with $V_{CC} = 13.6\text{ Vdc}$ and noting the power input. Then the Peak Envelope Power (PEP) is noted after doubling the original power input to simulate driver modulation.

$$\text{Percentage Up-Modulation} = \left[\left(\frac{\text{PEP}}{P_C} \right) - 1 \right] \bullet 100$$

FIGURE 2 – OUTPUT POWER versus INPUT POWER

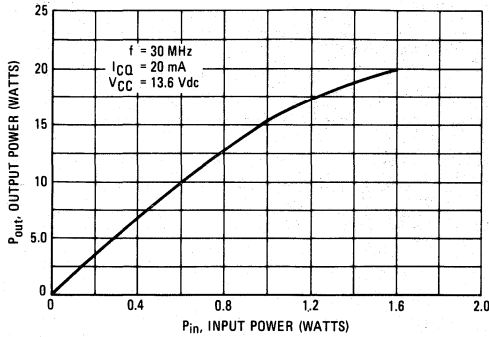


FIGURE 3 – INTERMODULATION DISTORTION versus OUTPUT POWER

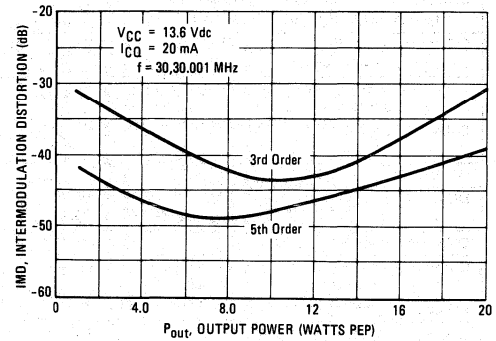


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

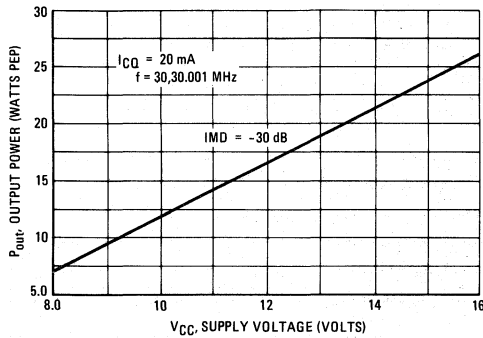


FIGURE 5 – OUTPUT CAPACITANCE versus FREQUENCY

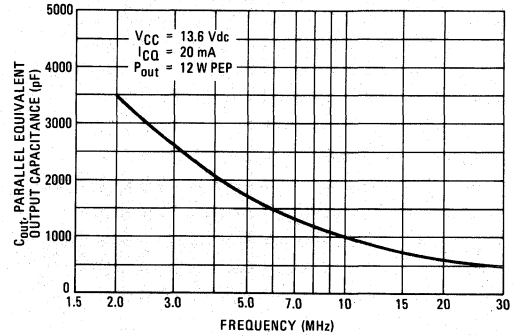


FIGURE 6 – OUTPUT RESISTANCE versus FREQUENCY

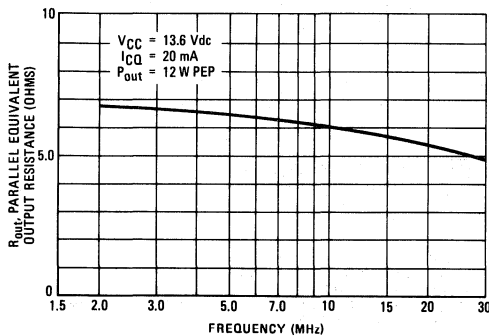


FIGURE 7 – POWER GAIN versus FREQUENCY

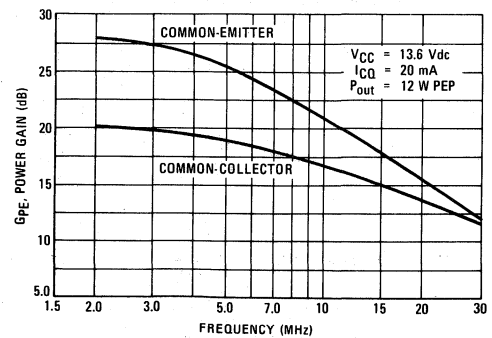


FIGURE 8 — IMPEDANCE COORDINATES — 50-OHM CHARACTERISTICS IMPEDANCE

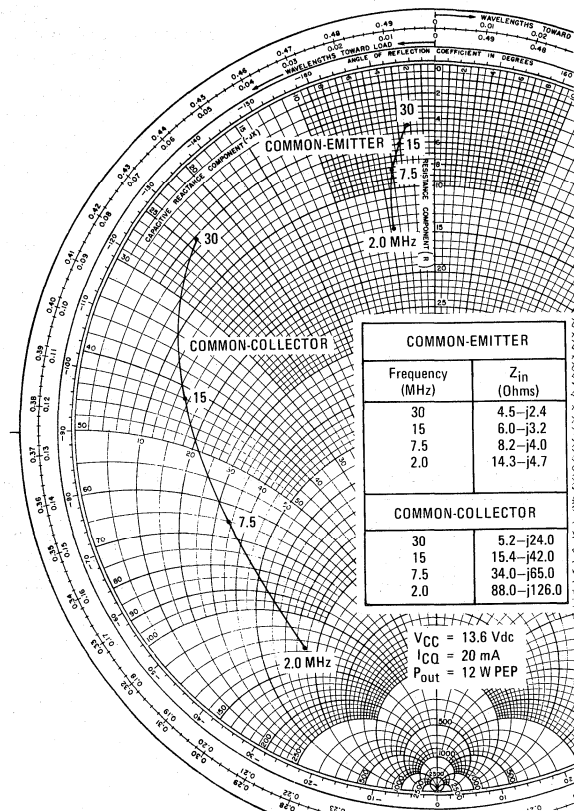
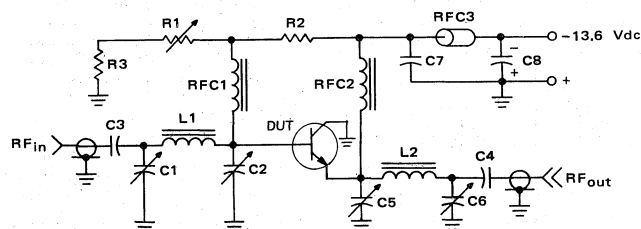


FIGURE 9 — COMMON-COLLECTOR TEST CIRCUIT



- C1, 5 — ARCO 466 Trimmer Capacitors
 C2 — ARCO 463 Trimmer Capacitor
 C3, 4, 7 — 0.1 μF Ceramic Disc
 C6 — ARCO 469 Trimmer Capacitor
 C8 — 100 μF 15 Vdc Electrolytic
 R1 — 250 Ω , 2.0 W Resistor
 R2 — 5.1 Ω , 1/2 W Resistor
 R3 — 51 Ω , 2.0 W Resistor

- L1 — 0.33 μH Molded Choke
 L2 — 4 Turns #18 AWG Wire, 1/8" I.D., 5/16" Long
 RFC1 — 18 μH Molded Choke
 RFC2 — 15 Turns #20 AWG Wire on 100 Ω , 1.0 W Carbon Resistor
 RFC3 — Ferroxcube, #56-590-65/3B, Beads on #18 AWG Wire

MRF476

The RF Line

NPN SILICON RF POWER TRANSISTOR

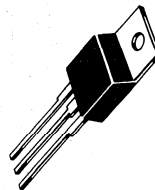
... designed primarily for use in single sideband linear amplifier output applications in citizens band and other communications equipment operating to 50 MHz.

- Characterized for Single Sideband and Large-Signal Amplifier Applications Utilizing Low-Level Modulation
- Specified 12.5 V, 30 MHz Characteristics —
 Output Power = 3.0 W (PEP)
 Minimum Efficiency = 40% (SSB)
 Output Power = 3.0 W (CW)
 Minimum Power Gain = 15 dB (PEP)
- Common-Collector Configuration

3.0 W (PEP)–3.0 W (CW) – 30 MHz

**RF POWER
 TRANSISTOR**

NPN SILICON



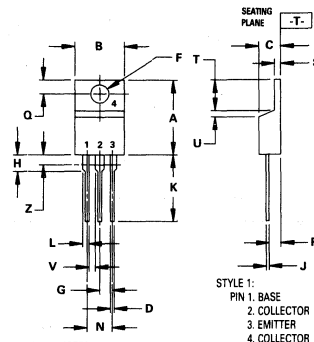
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	10 57.2	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	$^\circ\text{C/W}$



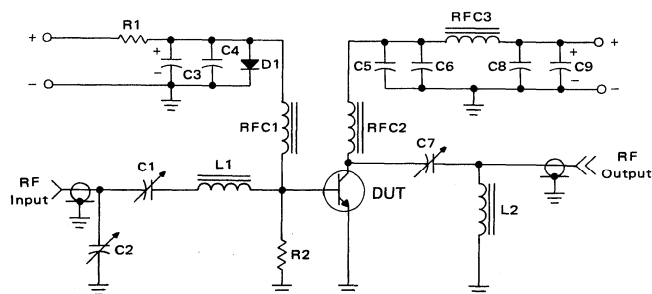
- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

**CASE 221A-04
 TO-220AB**

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAac
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250\text{ mAac}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	50	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	25	35	pF
FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 3.0\text{ W (PEP)}$ $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	G_{PE}	15	18	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 3.0\text{ W (PEP)}$ $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	η	40	—	—	%
Intermodulation Distortion ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 3.0\text{ W (PEP)}$ $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	IMD	-30	-35	—	dB
50 MHz PERFORMANCE					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 3.0\text{ W}$, $f = 50\text{ MHz}$)	G_{PE}	—	15	—	dB

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC

C2 — Arco 466 Trimmer
 C1, C7 — Arco 469 Trimmer
 C3 — 500 μF , 3.0 V Electrolytic
 C4, C5, C8 — 0.1 μF Erie Redcap
 C6 — 1000 pF UNELCO
 C9 — 100 μF , 15 V Electrolytic
 R1 — 33 Ω 5 W Wire Wound
 R2 — 50 Ω 1/2 W Carbon
 L1 — 0.22 μH Molded Choke
 L2 — 5 Turns #18 Enameled Wire, 1/4" ID

RFC1 — 10 μH Molded Choke
 RFC2 — 1.9 μH Molded Choke (Ohmite Z-144)
 RFC3 — 6 Ferroxcube Beads on #18 AWG Wire
 D1 — MR751
 Board — G10, 2-sided 2 oz. Copper Clad
 Connectors — Type N

FIGURE 2 – POWER GAIN versus FREQUENCY

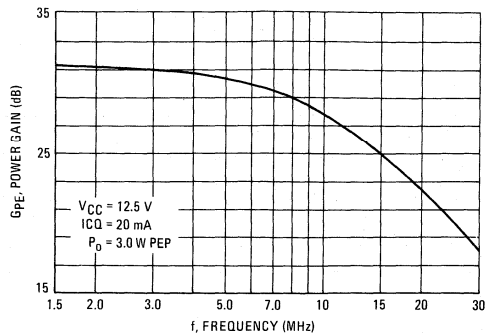


FIGURE 3 – OUTPUT POWER versus INPUT POWER

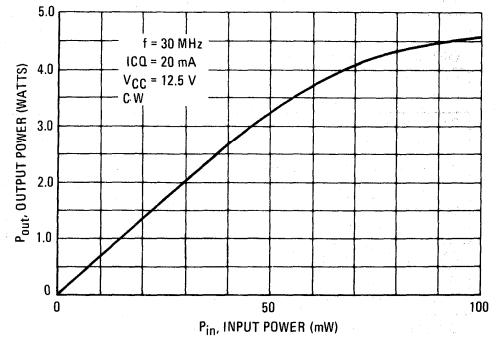


FIGURE 4 – OUTPUT POWER versus INPUT POWER

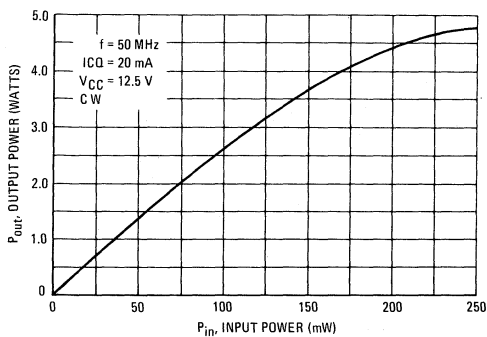


FIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE

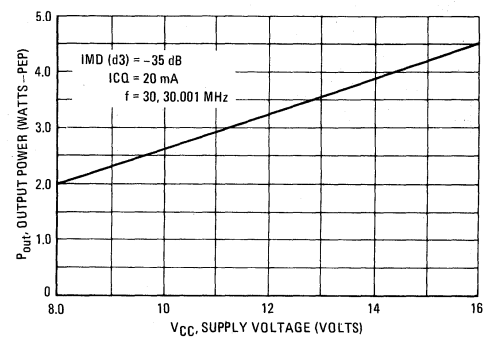
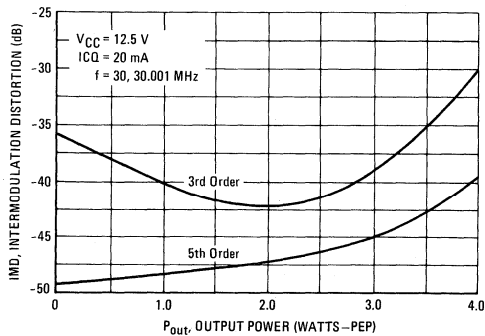
FIGURE 6 – INTERMODULATION DISTORTION
versus OUTPUT POWER

FIGURE 7 – OUTPUT CAPACITANCE versus FREQUENCY

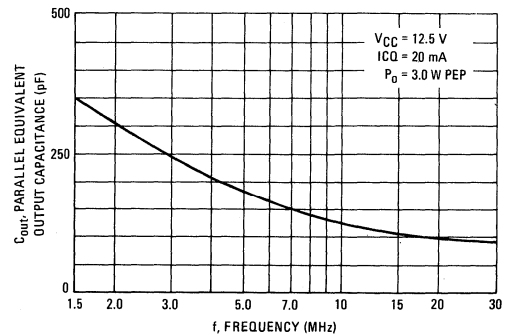


FIGURE 8 — OUTPUT RESISTANCE versus FREQUENCY

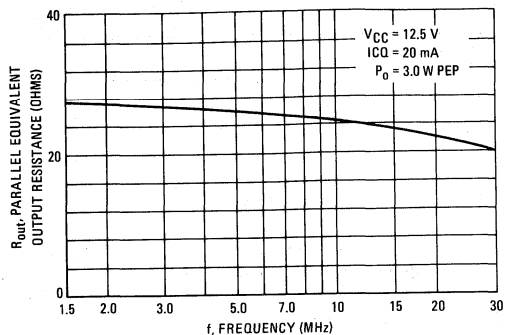
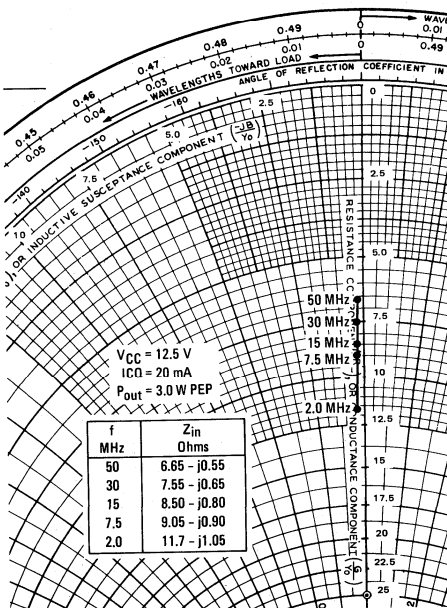


FIGURE 9 — SERIES EQUIVALENT INPUT IMPEDANCE



MRF477

The RF Line

NPN SILICON RF POWER TRANSISTOR

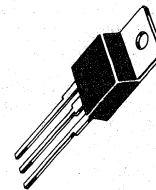
...designed primarily for application as a high-power linear amplifier from 1.5 to 30 MHz, in single sideband mobile, marine and base station equipment.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 Volt, 30 MHz Performance —
Output Power = 40 W CW or PEP
Power Gain = 15 dB Min
Efficiency = 40% Min (PEP)
- Intermodulation Distortion @ 40 W (PEP) —
IMD = -30 dB (Max)
- 30:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage

40 W (PEP) — 30 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



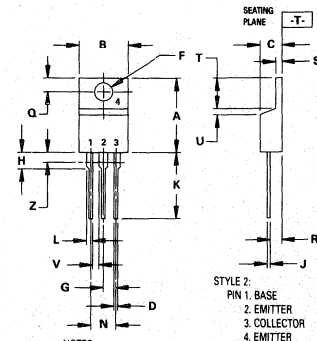
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Withstand Current ($t = 5.0$ s)	—	8.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	87.5 0.5	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.560
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

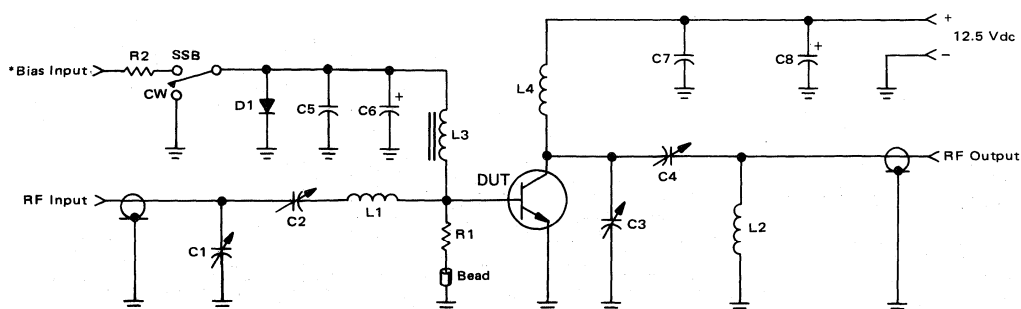
**CASE 221A-04
TO-220AB**

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 12.5\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	70	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	175	250	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 40\text{ mAdc}$)	G_{pE}	15	17	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 40\text{ mAdc}$)	η	40	45	—	%
Intermodulation Distortion (1) ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 40\text{ mAdc}$)	IMD (d_3)	—	-35	-30	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT



C1, C2, C4 — Arco 469, 190–780 pF

C3 — Arco 429, 90–400 pF

C5, C7 — 0.001 μF Disk CeramicsC6 — 500 μF 3.0 Vdc ElectrolyticC8 — 100 μF 16 Vdc ElectrolyticR1 — 10 Ω 1.0 Watt ResistorR2 — 5 Ω 5.0 Watt Resistor

L1 — 4 Turns #16 AWG 1/3" ID, 1/3" Long

L2 — 3 Turns #16 AWG 1/3" ID, 1/2" Long

L3 — 10 μH Molded Choke

L4 — 12 Turns #18 AWG 1/4" ID

Bead — Ferroxcube #56-590-65/3B

D1 — 1N4719

*Adjust Bias (Base) Voltage for $I_{CQ} = 40\text{ mA}$ with no RF applied.

FIGURE 2 – OUTPUT POWER versus INPUT POWER

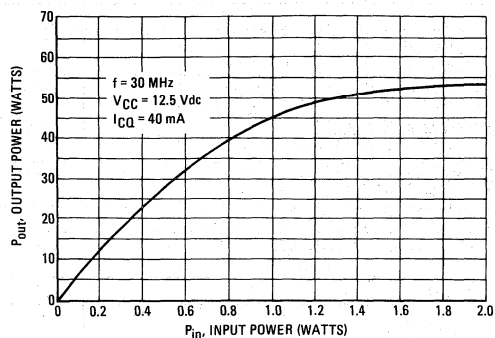


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

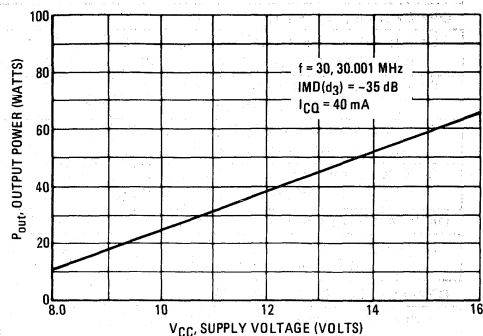


FIGURE 4 – POWER GAIN versus FREQUENCY

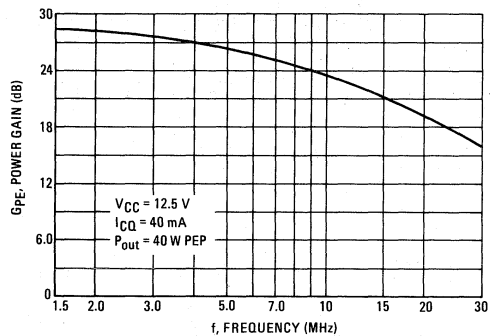


FIGURE 5 – INTERMODULATION DISTORTION versus OUTPUT POWER

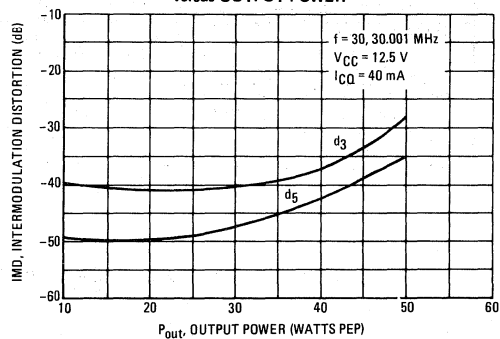


FIGURE 6 – SAFE OPERATING AREA

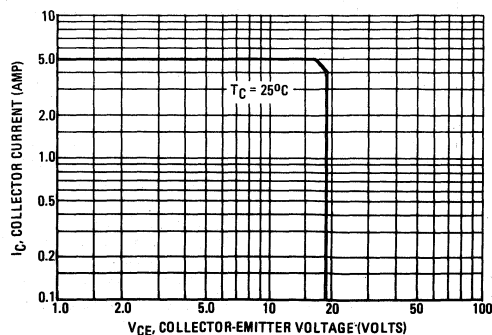


FIGURE 7 – SERIES EQUIVALENT INPUT IMPEDANCE

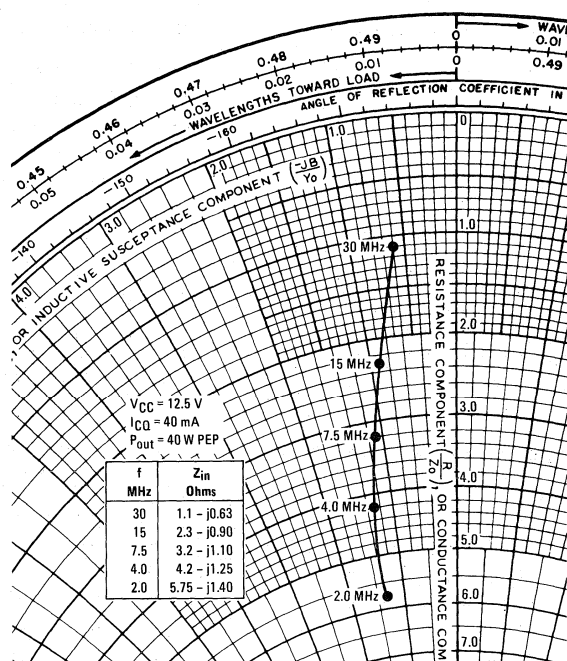


FIGURE 8 – OUTPUT CAPACITANCE versus FREQUENCY

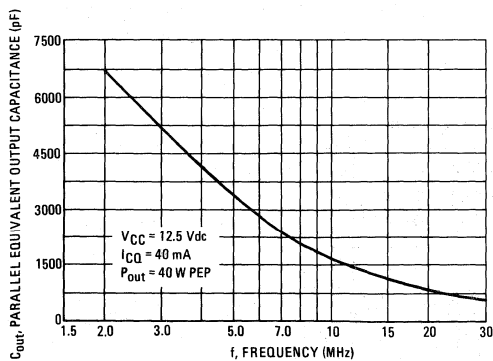
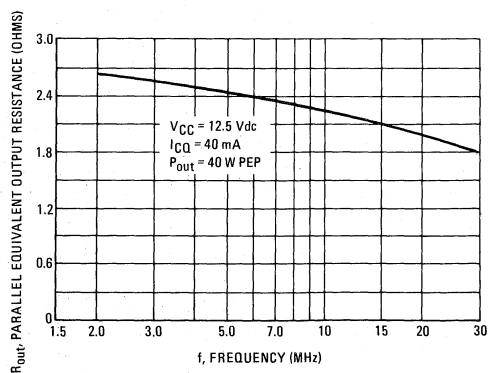


FIGURE 9 – OUTPUT RESISTANCE versus FREQUENCY



MRF479

The RF Line

NPN SILICON RF POWER TRANSISTOR

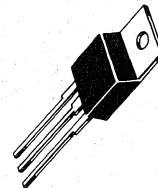
... designed primarily for use in single sideband linear amplifier output applications and other communications equipment operating to 50 MHz.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 V, 30 MHz Performance —
Output Power = 15 W (PEP) or (CW)
Power Gain = 12 dB Min
Efficiency = 40% Min
- Intermodulation Distortion @ 15 W (PEP) —
IMD = -30 dB (Max)
- 30:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage
- Characterized from 2.0 to 50 MHz

15 W (PEP), 15 W (CW)—30 MHz

RF POWER TRANSISTOR

NPN SILICON



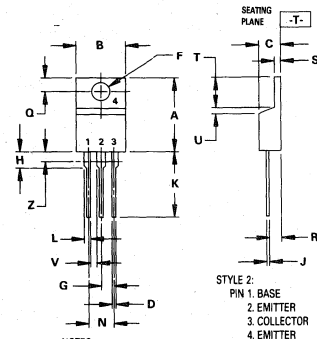
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.0	A dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	30 0.17	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.85	$^\circ\text{C/W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.56	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CES}	—	—	5.0	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	30	60	—	—
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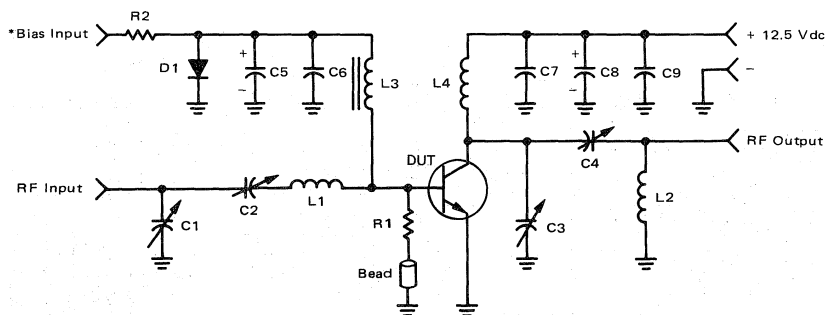
DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	125	155	pF
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FUNCTIONAL TESTS (SSB)

Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	G_{PE}	12	14	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	η	40	—	—	%
Intermodulation Distortion (1) (PEP) ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 20\text{ mA}$)	d_3	—	—	-30	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30-MHz COMMON EMITTER TEST CIRCUIT

C1, C2, C4 — 469 Arco 170–780 pF

C3 — 426 Arco 37–250 pF

C5 — 500 μF , 3.0 VC6, C7 — 0.1 μF Erie RedcapC8 — 0.01 μF Erie RedcapC9 — 100 μF , 16 V

L1 — 4 Turns #18 AWG 0.3" ID X 0.25"

L2 — 5 Turns #16 AWG 0.35" ID X 0.9"

L3 — 10 μH Molded Choke

L4 — 12 Turns #18 AWG 0.25" ID X 0.75"

R1 — 10 Ω , 1.0 WR2 — 5.0 Ω , 5.0 W

Bead — Ferroxcube Bead #56-590-65/3B

D1 — 1N4997

* Adjust Bias (Base) Voltage for $I_{CQ} = 20\text{ mA}$ with no RF applied.

FIGURE 2 – OUTPUT POWER versus INPUT POWER

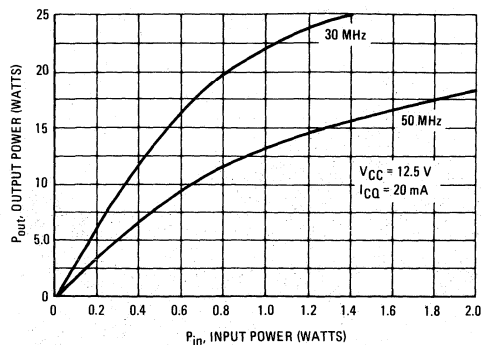


FIGURE 3 – POWER GAIN versus FREQUENCY

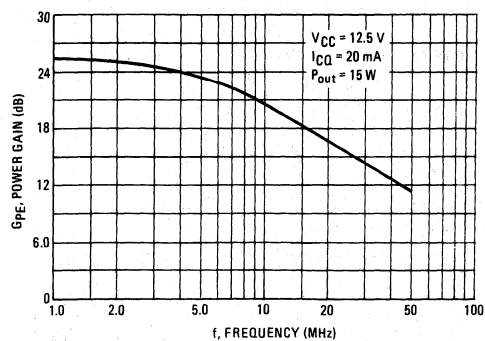


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

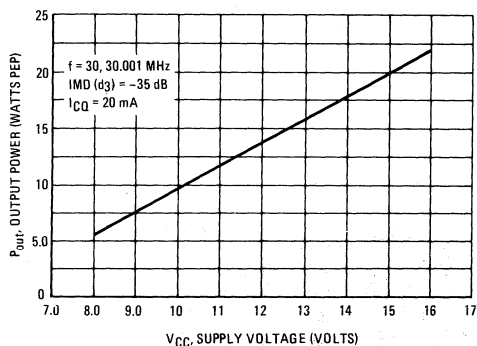


FIGURE 5 – INTERMODULATION DISTORTION versus OUTPUT POWER

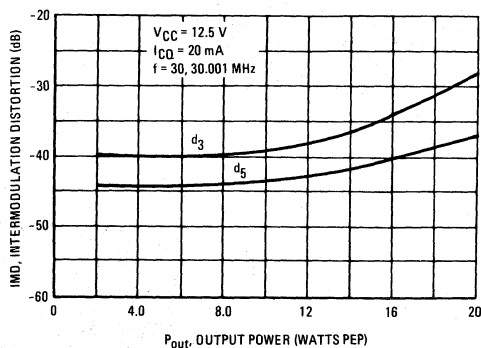


FIGURE 6 – OUTPUT CAPACITANCE versus FREQUENCY

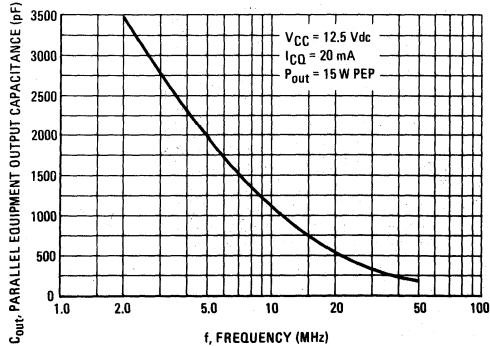


FIGURE 7 – OUTPUT RESISTANCE versus FREQUENCY

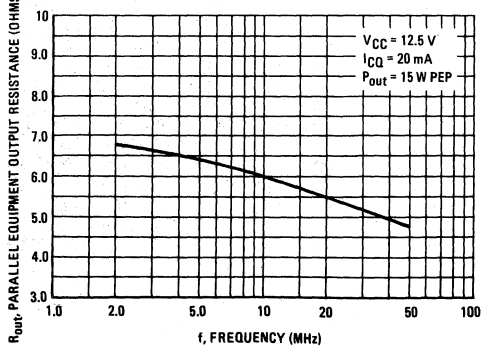


FIGURE 8 – SERIES EQUIVALENT INPUT IMPEDANCE

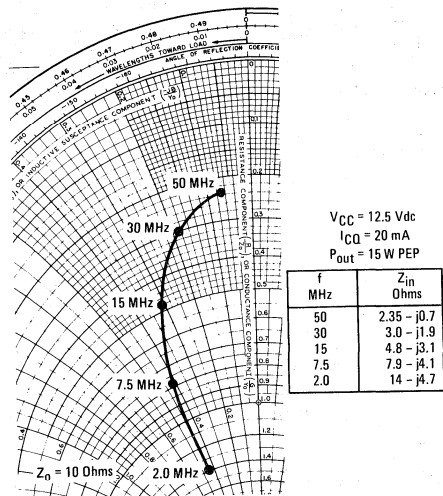


FIGURE 9 – 30 MHz TEST AMPLIFIER

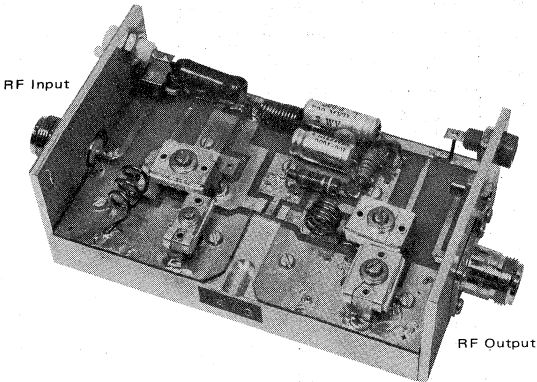
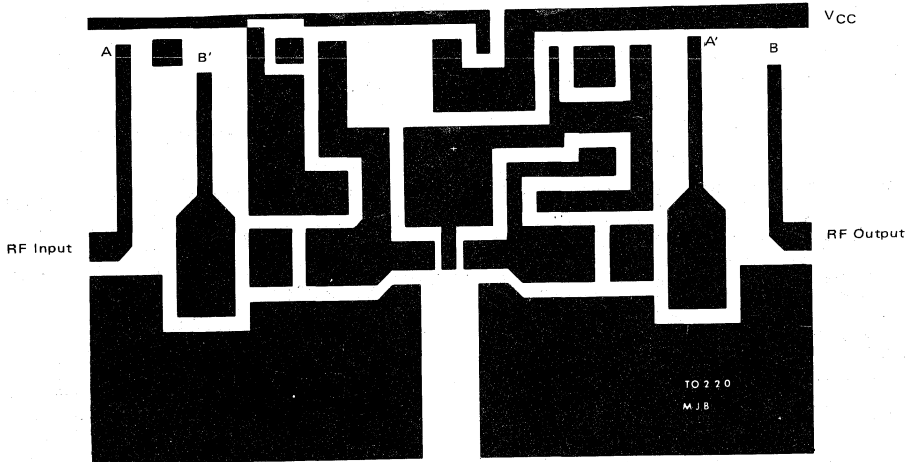


FIGURE 10 – TEST AMPLIFIER PCB PHOTOMASTER



NOTE: Points A, A' and B, B' are connected via 50 Ω coaxial cable under the PCB.
The Printed Circuit Board shown is 75% of the original.

MRF485

The RF Line

NPN SILICON RF POWER TRANSISTOR

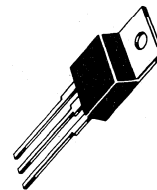
... designed primarily for use in single sideband linear amplifier output applications and other communications equipment operating to 30 MHz.

- Characterized for Single Sideband and Large-Signal Amplifier Applications Utilizing Low-Level Modulation
- Specified 28 V, 30 MHz Characteristics —
Output Power = 15 W (PEP)
Minimum Efficiency = 40% (SSB)
Minimum Power Gain = 10 dB (PEP & CW)
- Common-Collector Configuration

15 W (PEP) — 15 W (CW) — 30 MHz

RF POWER TRANSISTOR

NPN SILICON



MAXIMUM RATINGS

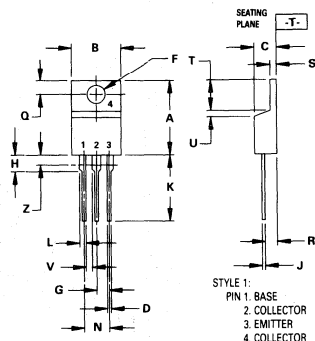
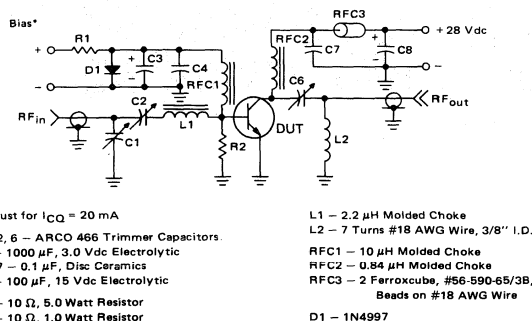
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 50^\circ\text{C}$ (1) Derate above 50°C	P_D	30 0.3	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.33	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

FIGURE 1 — COMMON-EMITTER TEST CIRCUIT



- NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 20 mA, I _B = 0)	V _{(BR)CEO}	35	—	—	Vdc
Collector-Emitter Breakdown Voltage (I _C = 50 mA, V _{BE} = 0)	V _{(BR)CES}	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 5.0 mA, I _C = 0)	V _{(BR)EBO}	4.0	—	—	Vdc
Collector Cutoff Current (V _{CB} = 25 Vdc, I _E = 0)	I _{CBO}	—	—	1.0	mA
Collector-Cutoff Current (V _{CE} = 28 Vdc, V _{BE} = 0)	I _{CES}	—	—	5.0	mA

DC Current Gain (I _C = 500 mA, V _{CE} = 5.0 Vdc)	h _{FE}	10	30	—	—
---	-----------------	----	----	---	---

Output Capacitance (V _{CB} = 28 Vdc, I _E = 0, f = 1.0 MHz)	C _{ob}	—	85	100	pF
---	-----------------	---	----	-----	----

FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Power Gain (V _{CC} = 28 Vdc, P _{out} = 15 W (PEP), f ₁ = 30 MHz, f ₂ = 30.001 MHz, I _{CQ} = 20 mA)	G _{PE}	10	13	—	dB
Collector Efficiency (V _{CC} = 28 Vdc, P _{out} = 15 W (PEP), f ₁ = 30 MHz, f ₂ = 30.001 MHz, I _{CQ} = 20 mA)	η	40	—	—	%
Intermodulation Distortion (1) (V _{CC} = 28 Vdc, P _{out} = 15 W (PEP), f ₁ = 30 MHz, f ₂ = 30.001 MHz, I _{CQ} = 20 mA)	IMD(d3)	—	−35	−30	dB
Load Mismatch (V _{CC} = 28 Vdc, P _{out} = 15 W (PEP), f ₁ = 30 MHz, f ₂ = 30.001 MHz, VSWR = 30:1 All Angles)	ψ	No Degradation in Output Power			

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

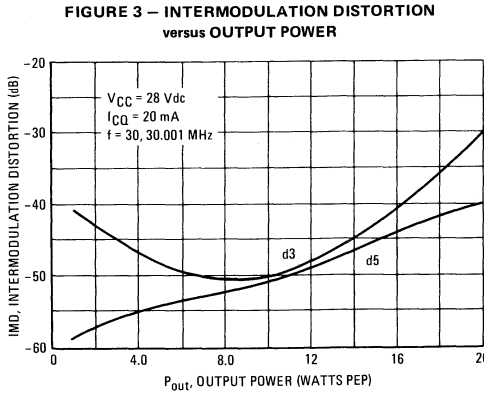
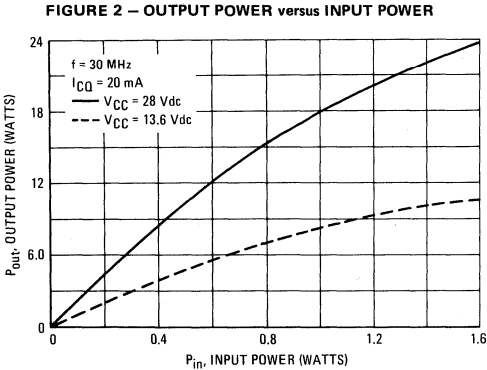


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

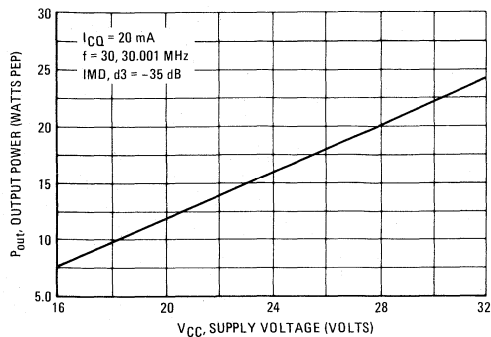


FIGURE 5 – OUTPUT CAPACITANCE versus FREQUENCY

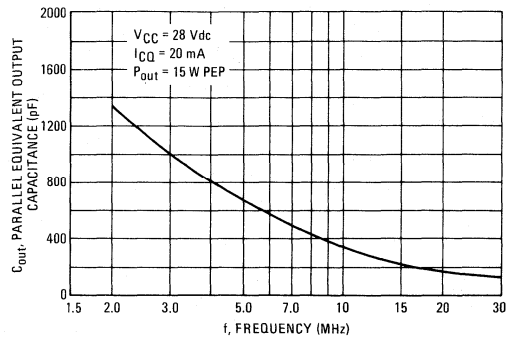


FIGURE 6 – OUTPUT RESISTANCE versus FREQUENCY

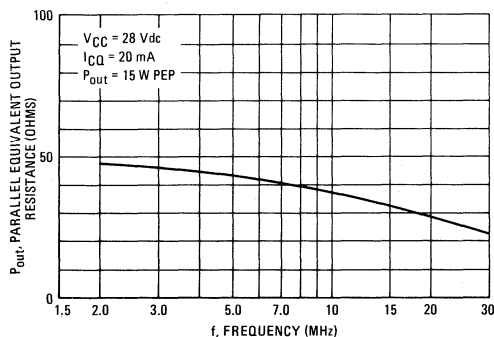


FIGURE 7 – POWER GAIN versus FREQUENCY

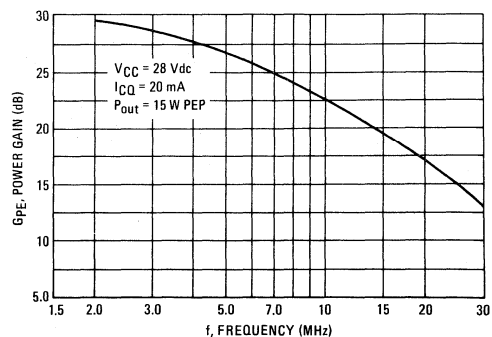
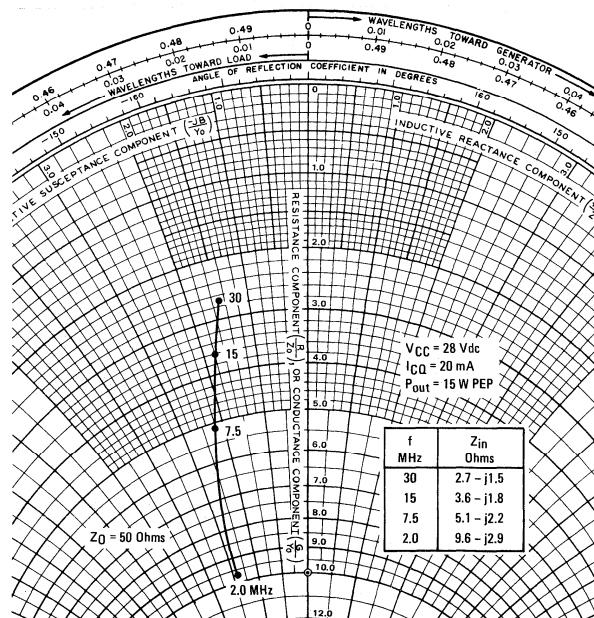


FIGURE 8 – SERIES EQUIVALENT INPUT IMPEDANCE



The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for application as a high-power linear amplifier from 1.5 to 30 MHz, in single sideband mobile, marine and base station equipment.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 28 Volt, 30 MHz Performance —
Output Power = 40 W (PEP)
Power Gain = 15 dB Min
Efficiency = 40% Min
- Intermodulation Distortion @ 40 W (PEP) —
IMD = -30 dB (Max)
- 30:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage

MAXIMUM RATINGS

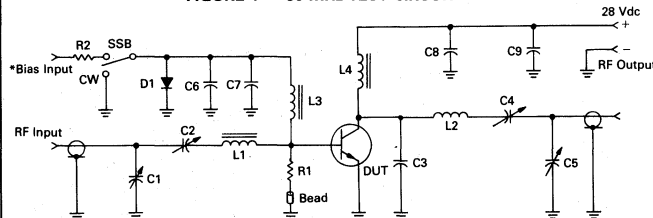
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.0	Adc
Withstand Current ($t = 5.0$ s)	—	6.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	87.5 0.5	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	$^\circ\text{C/W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

FIGURE 1 — 30 MHz TEST CIRCUIT



C1, C2 — Arco 469, 190-780 pF
C3 — 150 pF ELMENCO**
C4, C5 — Arco 429, 90-400 pF
C6, C9 — 0.001 μF Disc Ceramics
C7 — 500 μF , 3.0 Vdc Electrolytic
C8 — 50 μF , 50 Vdc, Electrolytic

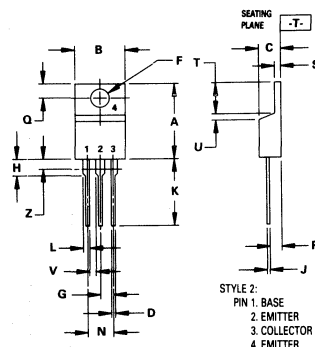
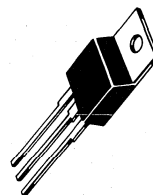
R1 — 10 Ω , 1.0 Watt Resistor
R2 — 5.0 Ω , 5.0 Watt Resistor
L1 — 0.15 μH Molded Choke
L2 — 7 Turns, #16 AWG Enameled Close-Wound, 1/2" ID
L3 — 10 μH Molded Choke
L4 — 1.9 μH Molded Choke
One Bead — #56-590-65/3B (Ferroxcube or equiv.)
D1 — 1N4997

*Adjust Bias (Base) Voltage for $I_{CQ} = 40$ mA with no RF applied.
**Type MCM01/010 or UNELCO 3 HS 0006.

MRF486

40 W (PEP) — 30 MHz

RF POWER
TRANSISTOR
NPN SILICON



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.84	0.89	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.73	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	10	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	40	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 27\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	130	200	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 40\text{ mA}$)	G_{PE}	15	17.5	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 40\text{ mA}$)	η	40	45	—	%
Intermodulation Distortion (1) ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 40\text{ W (PEP)}$, $f_1 = 30\text{ MHz}$, $f_2 = 30.001\text{ MHz}$, $I_{CQ} = 40\text{ mA}$)	$IMD(d_3)$	—	-35	-30	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

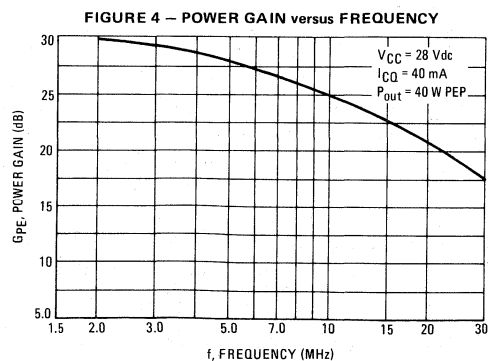
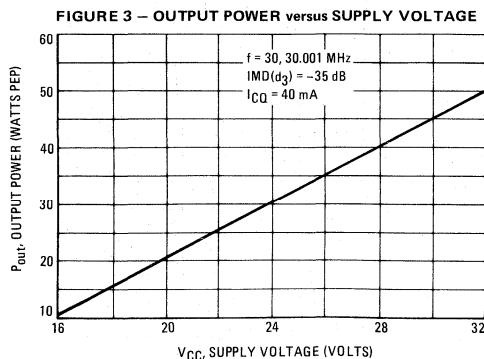
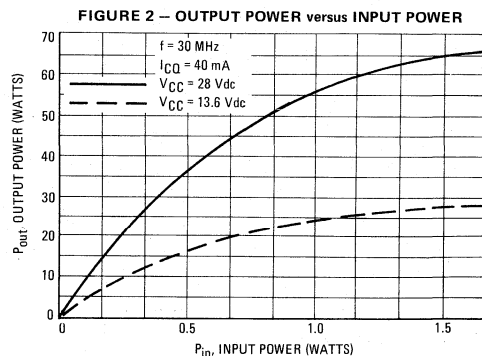


FIGURE 5 — INTERMODULATION DISTORTION
versus OUTPUT POWER

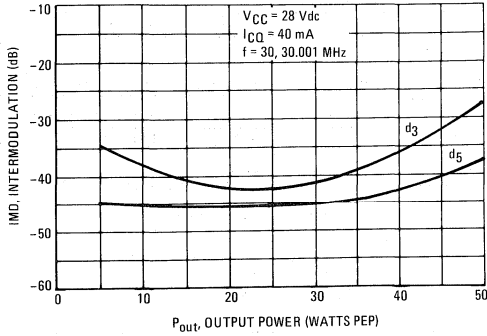


FIGURE 6 — SAFE OPERATING AREA

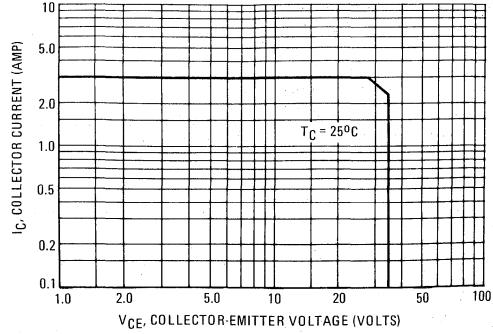


FIGURE 7 — SERIES EQUIVALENT INPUT IMPEDANCE

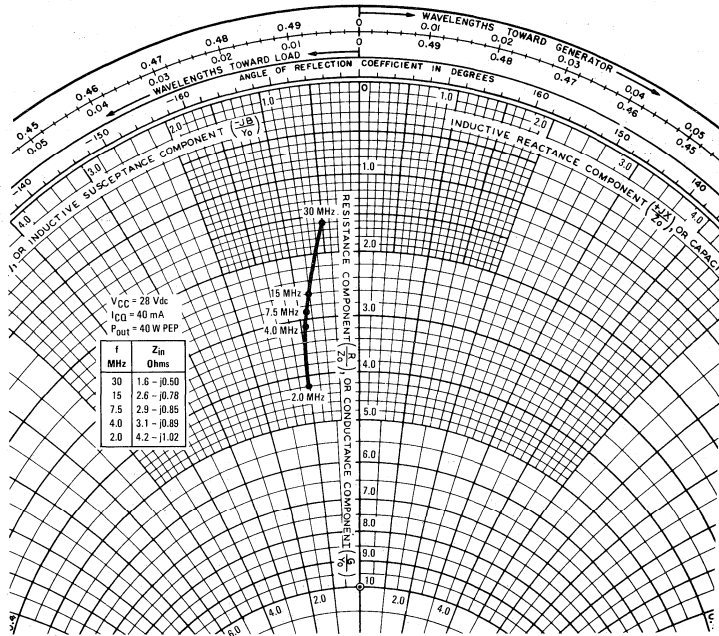


FIGURE 8 — OUTPUT CAPACITANCE versus FREQUENCY

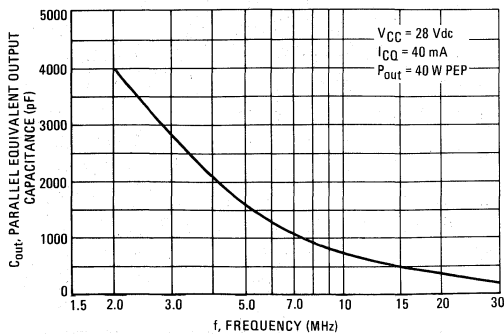
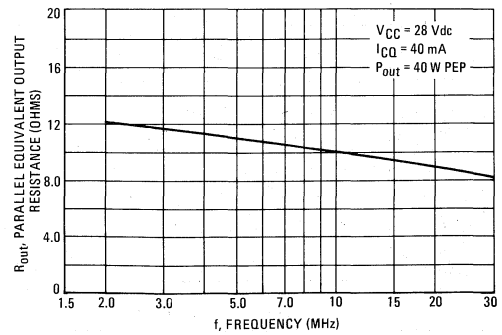


FIGURE 9 — OUTPUT RESISTANCE versus FREQUENCY



MOTOROLA SEMICONDUCTOR TECHNICAL DATA

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 volt low band VHF large-signal power amplifier applications in commercial and industrial FM equipment.

- Specified 12.5 V, 50 MHz Characteristics —
Output Power = 70 W
Minimum Gain = 11 dB
Efficiency = 50%
- Load Mismatch Capability at High Line and RF Overdrive

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	20	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	250 1.43	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	0.7	$^\circ\text{C}/\text{W}$

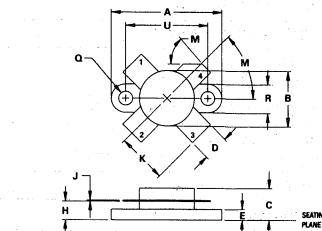
- These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF492 MRF492A

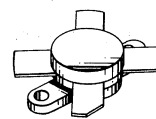
70 W 50 MHz

RF POWER TRANSISTOR

NPN SILICON



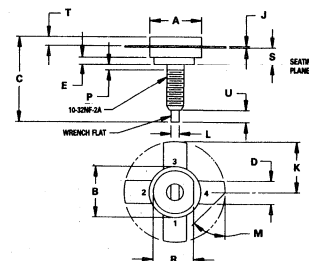
NOTES:
1. DIMENSIONING AND TOLERANCING PER
ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.



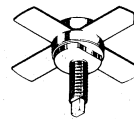
STYLE 1:
PIN 1: EMITTER
2: BASE
3: EMITTER
4: COLLECTOR

CASE 211-11
MRF492

DIM	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.85	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
F	3.95	4.52	0.154	0.178
G	0.08	0.17	0.003	0.007
H	11.05	—	0.435	—
I	45° NCM	45° NCM	—	—
J	2.93	3.30	0.115	0.130
K	5.25	6.47	0.206	0.255
L	18.29	18.54	0.720	0.730



NOTES:
1. DIMENSIONING AND TOLERANCING
PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.



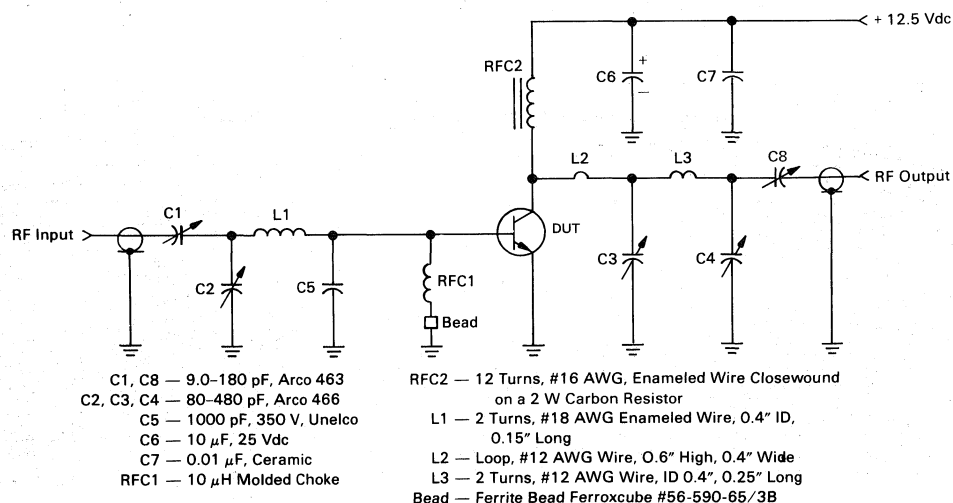
STYLE 1:
PIN 1: EMITTER
2: BASE
3: EMITTER
4: COLLECTOR

CASE 145A-10
MRF492A

DIM	MIN	MAX	MIN	MAX
A	12.45	12.95	0.490	0.510
B	10.54	10.80	0.415	0.425
C	19.68	22.73	0.775	0.895
D	5.46	5.97	0.215	0.235
E	1.83	—	0.072	—
F	0.08	0.18	0.003	0.007
G	12.45	—	0.490	—
H	1.66	1.90	0.065	0.075
I	45° NCM	45° NCM	—	—
J	—	1.27	—	0.050
K	9.73	10.06	0.383	0.396
L	3.94	4.50	0.151	0.177
M	2.11	2.54	0.083	0.100
N	2.49	3.35	0.098	0.132

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 13.6\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	20	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	275	450	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 70\text{ W}$, $f = 50\text{ MHz}$)	G_{PE}	11	13	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 70\text{ W}$, $f = 50\text{ MHz}$)	η	50	—	—	%

FIGURE 1 — 50 MHz TEST CIRCUIT

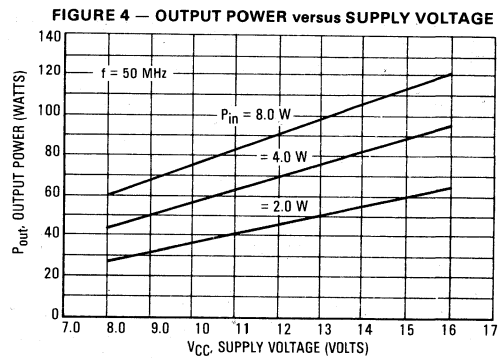
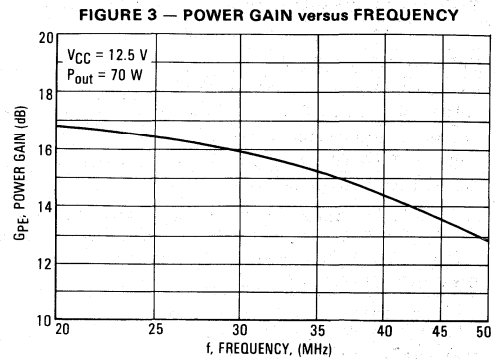
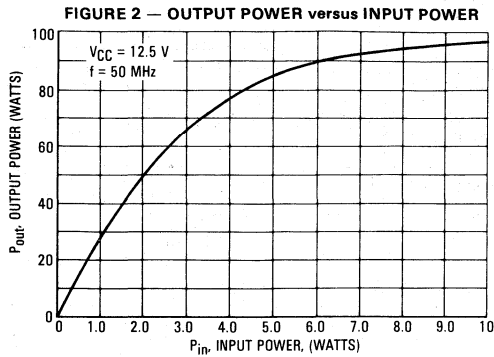
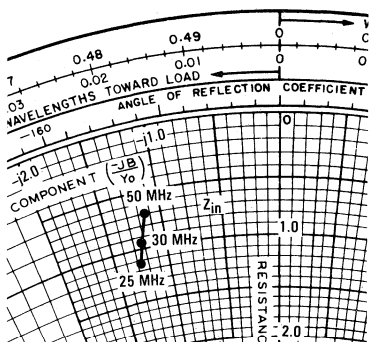


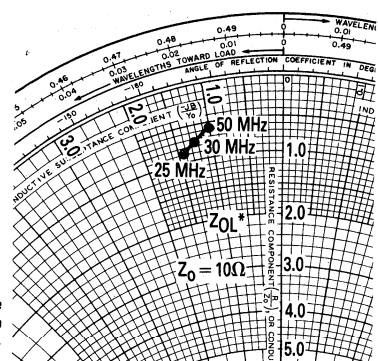
FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



$V_{CC} = 12.5 \text{ V}, P_{out} = 70 \text{ W}$

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
50	$0.7 - j1.17$	$0.58 - j1.0$
30	$0.93 - j1.24$	$0.76 - j1.3$
25	$1.12 - j1.28$	$0.85 - j1.46$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 volt VHF large-signal power amplifier applications in commercial and industrial equipment, operating in the 25 to 50 MHz frequency range.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 V, 50 MHz Performance —
Output Power = 40 Watts
Power Gain = 10 dB Min
Efficiency = 60% Min
- Load Mismatch Capability at Rated Voltage and RF Drive

MAXIMUM RATINGS

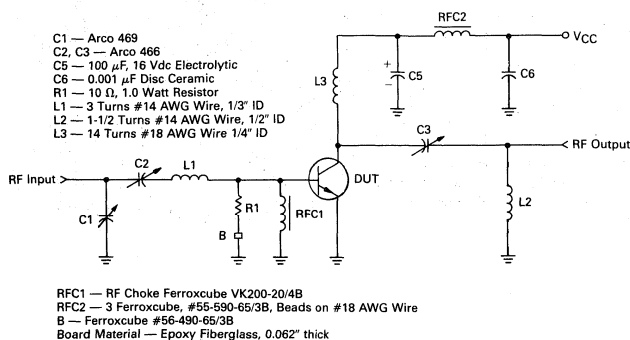
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	6.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	87.5 0.5	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	2.0	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

FIGURE 1 — 50 MHz TEST CIRCUIT

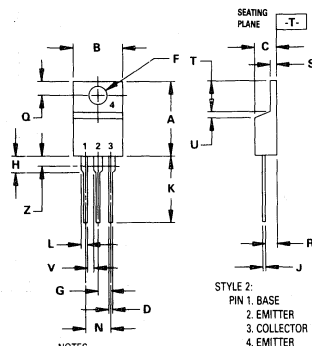
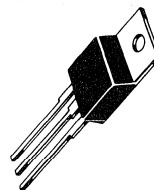


MRF497

40 W 50 MHz

RF POWER TRANSISTOR

NPN SILICON



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1992.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	—	—	—
---	----------	----	---	---	---

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	250	pF
---	----------	---	---	-----	----

FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 40\text{ W}$, $f = 50\text{ MHz}$)	G_{PE}	10	11.2	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 40\text{ W}$, $f = 50\text{ MHz}$)	η	60	—	—	%

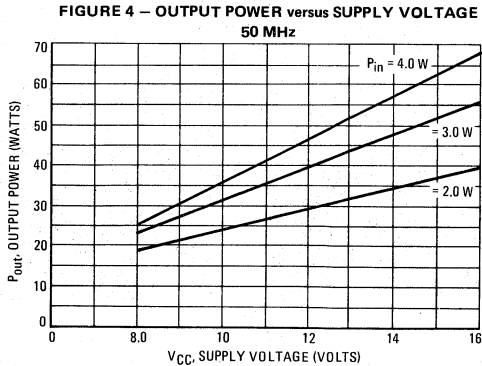
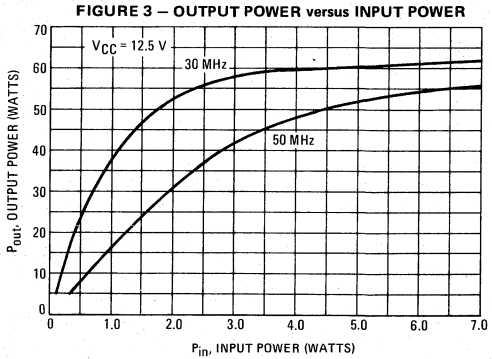
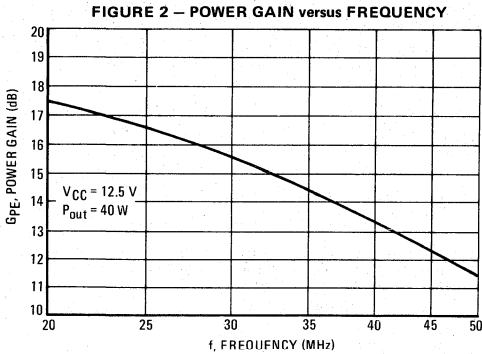


FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

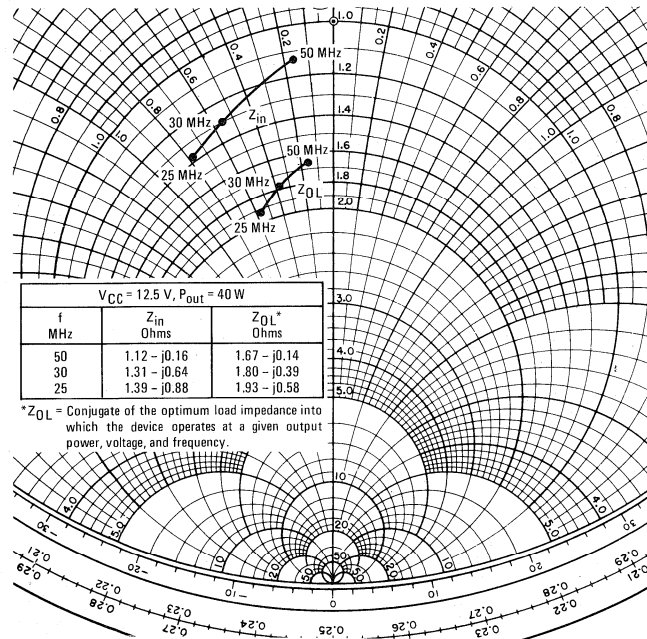
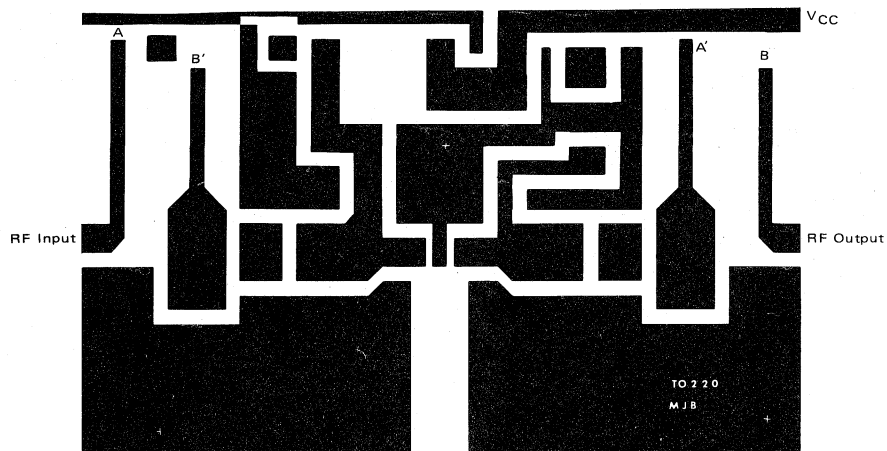


FIGURE 6 — TEST AMPLIFIER PCB PHOTOMASTER



NOTE: Points A, A' and B, B' are connected via 50 Ω coaxial cable under the PCB.
The Printed Circuit Board shown is 75% of the original.

MRF501
MRF502

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

... designed primarily for use in high-gain, low-noise amplifier, oscillator, and mixer applications. Can also be used in UHF converter applications.

- High Current-Gain – Bandwidth Product –
 $f_T = 1.2 \text{ GHz (Typ) @ } I_C = 5.0 \text{ mAdc}$
- Low Noise Figure –
 $NF = 4.0 \text{ dB (Typ) @ } f = 200 \text{ MHz}$

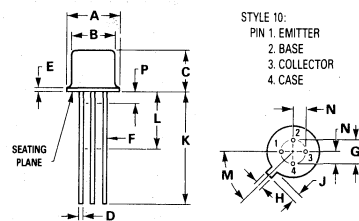
HIGH FREQUENCY
TRANSISTORS

NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	MRF501	MRF502	Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Base Voltage	V_{CBO}	25	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5		Vdc
Collector Current	I_C	50		mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	200 1.14		mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200		$^\circ\text{C}$



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72
 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 3.0 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1.0 \text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	25 35	— —	— —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 1.0 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	— —	— —	50 20	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0 \text{ mA}$, $V_{CE} = 6.0 \text{ Vdc}$)	h_{FE}	30 40	— —	250 170	—
DYNAMIC CHARACTERISTICS					
Current Gain — Bandwidth Product ($I_C = 5.0 \text{ mA}$, $V_{CE} = 6.0 \text{ Vdc}$, $f = 100 \text{ MHz}$)	f_T	600 800	1000 1200	— —	MHz
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 0.1$ to 1.0 MHz)	C_{cb}	—	0.6	—	pF
Collector-Base Time Constant ($I_E = 2.0 \text{ mA}$, $V_{CB} = 6.0 \text{ Vdc}$, $f = 31.8 \text{ MHz}$)	$\tau_{b'c}$	—	8.0	—	ps
Noise Figure (Figure 1) ($I_C = 1.5 \text{ mA}$, $V_{CE} = 6.0 \text{ Vdc}$, $R_S = 50 \text{ ohms}$, $f = 200 \text{ MHz}$)	NF	— —	4.5 4.0	— —	dB
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 1) ($V_{CC} = 6.0 \text{ Vdc}$, $I_C = 5.0 \text{ mA}$, $f = 200 \text{ MHz}$)	G_{pe}	— —	15 17	— —	dB

MRF511

The RF Line

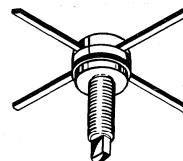
NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed specifically for broadband applications requiring low distortion characteristics and noise figure. Specified for use in CATV applications.

- Specified +50 dBmV Output, 80 mAdc Distortion Characteristics –
Triple Beat = -65 dB (Max)
Cross Modulation = -57 dB (Max)
Second Order = -50 dB (Max)
- High Broadband Power Gain –
 $G_{pe} = 10 \text{ dB (Min) @ } f = 250 \text{ MHz}$
- Low Broadband Noise Figure –
 $NF = 10 \text{ dB (Max) @ } f = 200 \text{ MHz}$

**HIGH FREQUENCY
TRANSISTOR**

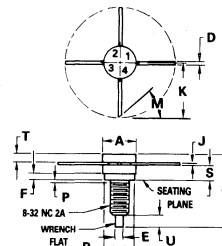
NPN SILICON



MAXIMUM RATINGS

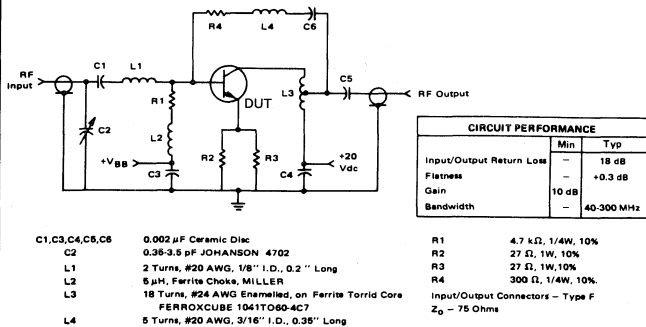
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	20	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current – Continuous	I_C	250	mAdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	5.0 28.6	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Stud Torque ⁽¹⁾	—	6.5	In. Lb.

(1) For Repeated Assembly use 5 In. Lb.



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

FIGURE 1 — 40 to 330 MHz BROADBAND TEST CIRCUIT SCHEMATIC



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	15.24	16.51	0.600	0.650
D	0.66	0.86	0.026	0.034
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.10	0.15	0.004	0.006
K	11.17	—	0.440	—
M	45° NOM	45° NOM	—	—
P	—	1.27	—	0.050
S	2.74	3.35	0.108	0.132
T	1.40	1.78	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244A-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{Adc}$, $I_E = 0$)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	100	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 80\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	25	50	200	—
Collector-Emitter Saturation Voltage ($I_C = 100\text{ mAdc}$, $I_B = 10\text{ mAdc}$)	$V_{CE(sat)}$	—	0.2	0.5	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product ($I_C = 80\text{ mAdc}$, $V_{CE} = 20\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	1.5	2.1	—	GHz
Output Capacitance ($V_{CB} = 20\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	3.2	4.5	pF
Noise Figure ($I_C = 50\text{ mAdc}$, $V_{CE} = 20\text{ Vdc}$, $f = 200\text{ MHz}$)	NF	—	7.3	10	dB
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CE} = 20\text{ Vdc}$, $I_C = 80\text{ mAdc}$, $f = 250\text{ MHz}$)	G_{pe}	10	11	—	dB
2nd Order Intermodulation Distortion ($V_{CE} = 20\text{ Vdc}$, $I_C = 80\text{ mAdc}$, $V_{out} = +50\text{ dBmV}$, Chn 2 + Chn 13 = 266.5 MHz)	IMD	—	-55	-50	dB
Cross-Modulation Distortion ($V_{CE} = 20\text{ Vdc}$, $V_{out} = +50\text{ dBmV}$, $I_C = 80\text{ mAdc}$)	Chn 13 Chn R	12 Chn XMD 30 Chn XMD	— -59 -46	-57 —	dB
Triple Beat ($V_{CE} = 20\text{ Vdc}$, $I_C = 80\text{ mAdc}$, $V_{out} = +50\text{ dBmV}$, Chn 2 + Chn 3 + Chn E = 261.75 MHz)	TB	—	-68	-65	dB

FIGURE 2 – CURRENT-GAIN-BANDWIDTH PRODUCT

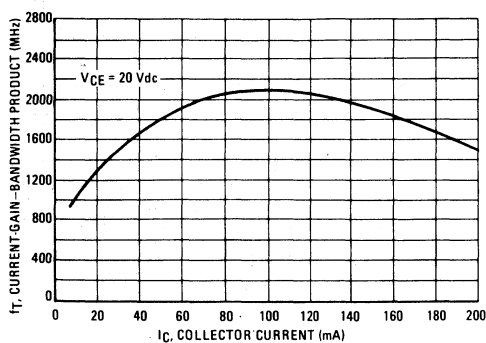


FIGURE 3 – OUTPUT CAPACITANCE

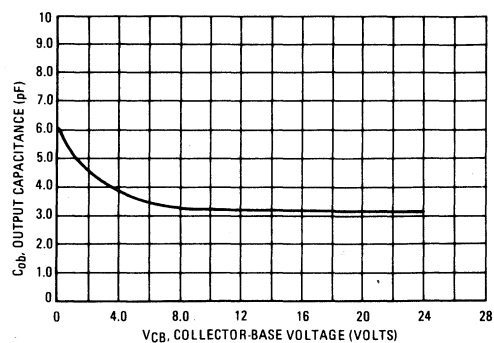


FIGURE 4 – INPUT CAPACITANCE

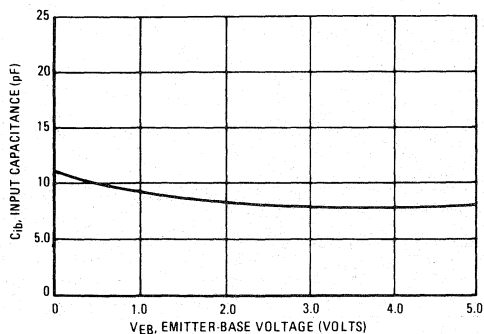


FIGURE 5 – BROADBAND NOISE FIGURE

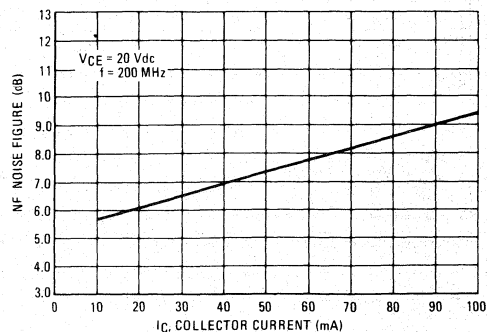
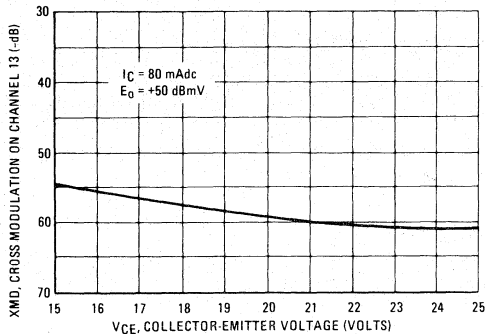
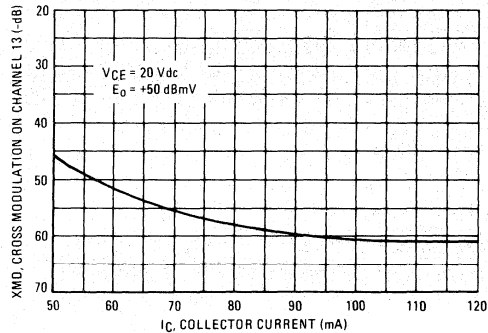
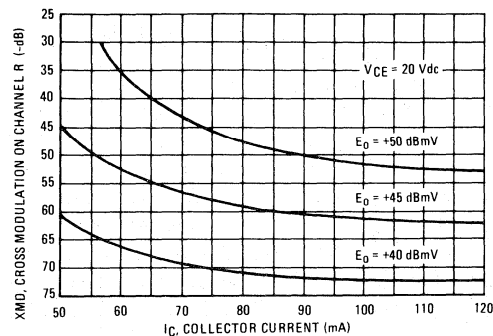
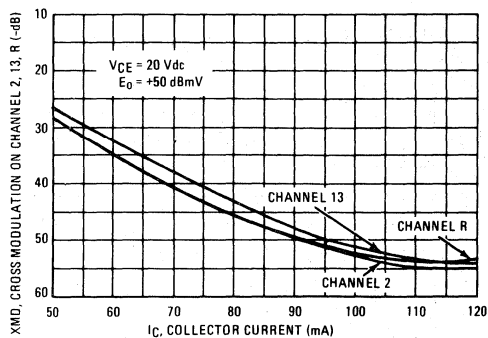
FIGURE 6 – 12 CHANNEL CROSS-MODULATION
versus COLLECTOR-EMITTER VOLTAGEFIGURE 7 – 12 CHANNEL CROSS-MODULATION
versus COLLECTOR CURRENTFIGURE 8 – 30 CHANNEL CROSS-MODULATION
ON CHANNEL RFIGURE 9 – 30 CHANNEL CROSS-MODULATION
ON CHANNEL 2,13,R

FIGURE 10 – 30-CHANNEL CROSS-MODULATION versus COLLECTOR-EMITTER VOLTAGE

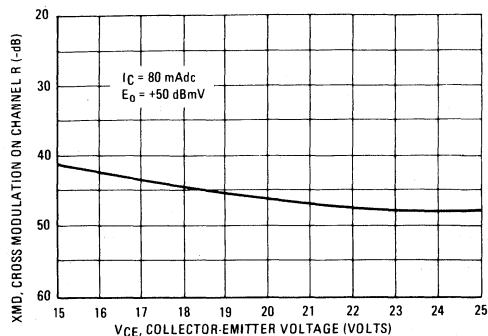


FIGURE 11 – TRIPLE BEAT versus COLLECTOR CURRENT

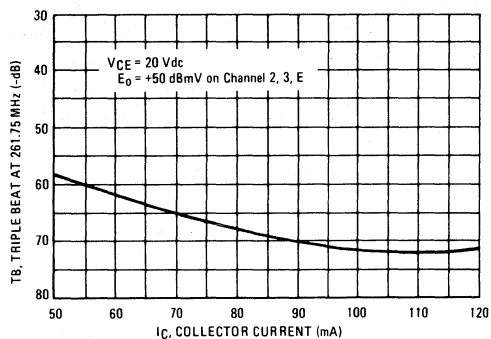


FIGURE 12 – TRIPLE BEAT versus COLLECTOR-EMITTER VOLTAGE

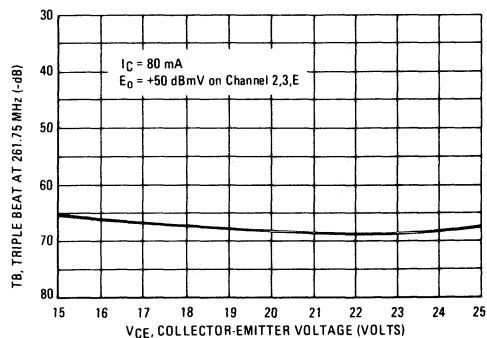


FIGURE 13 – SECOND ORDER IMD versus COLLECTOR CURRENT

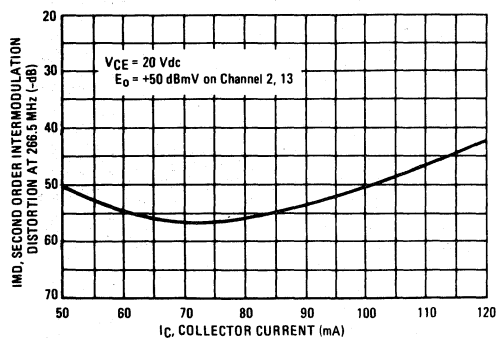


FIGURE 14 – SECOND ORDER IMD versus COLLECTOR-EMITTER VOLTAGE

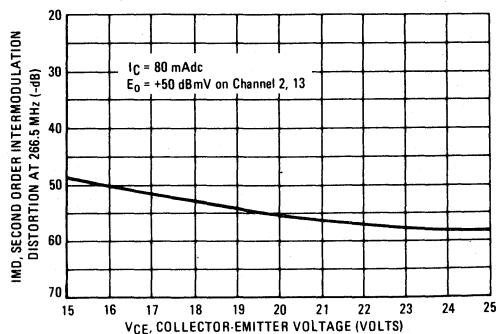


FIGURE 15 – INPUT REFLECTION COEFFICIENT (S11) AND OUTPUT REFLECTION COEFFICIENT (S22) versus FREQUENCY

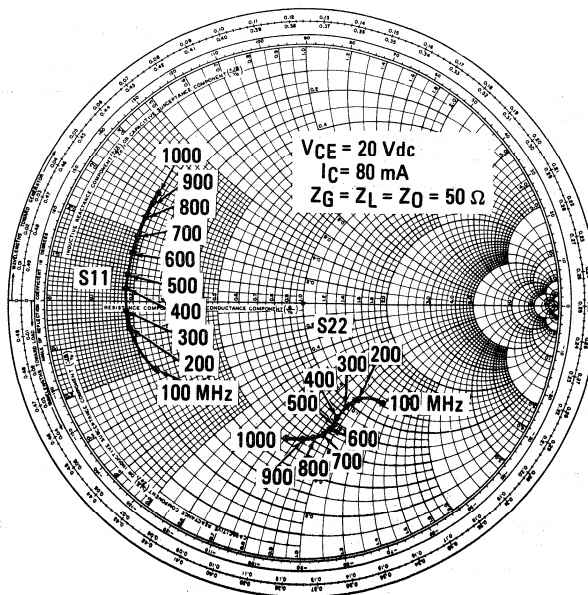


FIGURE 16 – FORWARD TRANSMISSION COEFFICIENT (S12) versus FREQUENCY

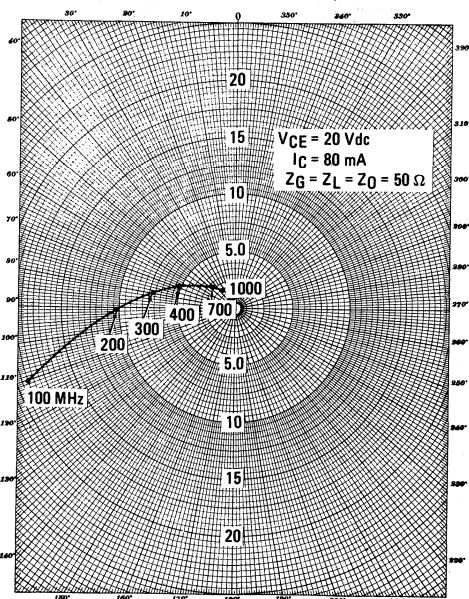
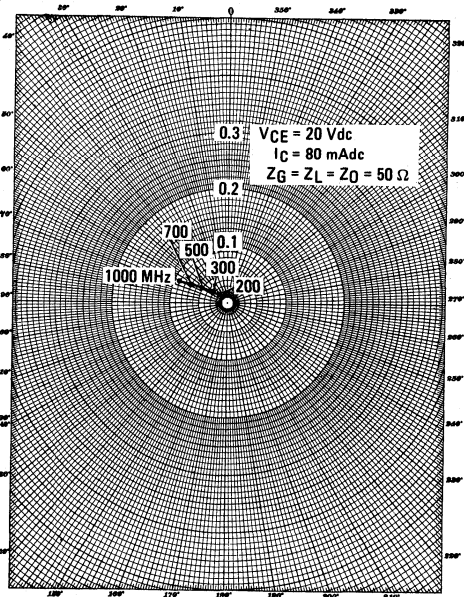


FIGURE 17 – REVERSE TRANSMISSION COEFFICIENT (S21) versus FREQUENCY



The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

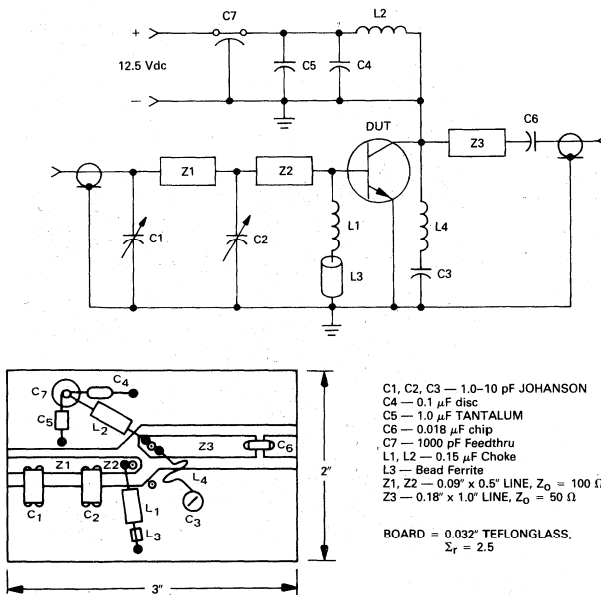
... designed for 12.5 Volt UHF large-signal amplifier applications required in industrial equipment

- Specified 12.5 Volt, 470 MHz Characteristics —
Output Power = 0.75 Watts
Minimum Gain = 8.0 dB
Efficiency = 50%
- S Parameter Data From 100 MHz to 1.0 GHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	150	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	2.5 14.3	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

FIGURE 1 — 470 MHz TEST CIRCUIT

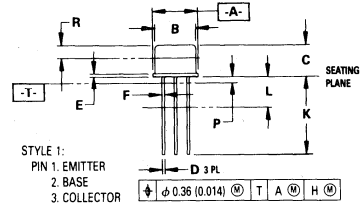
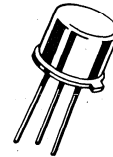


MRF515

0.75 W — 470 MHz

HIGH FREQUENCY TRANSISTOR

NPN SILICON



- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 - CONTROLLING DIMENSION: INCH.
 - DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
 - DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
 - DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$, $I_E = 0$)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{A}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	10	μA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	20	60	150	—
Collector-Emitter Saturation Voltage ($I_C = 50\text{ mA}$, $I_B = 5.0\text{ mA}$)	$V_{CE(sat)}$	—	—	0.5	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	1800	2000	—	MHz
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	3.5	4.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.75\text{ W}$, $f = 470\text{ MHz}$)	G_{pE}	8.0	8.5	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.75\text{ W}$, $f = 470\text{ MHz}$)	η	50	70	—	%
Series Equivalent Input Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.75\text{ W}$, $f = 470\text{ MHz}$)	Z_{in}	—	$14 + j4.0$	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.75\text{ W}$, $f = 470\text{ MHz}$)	Z_{out}	—	$28 - j38$	—	Ohms

FIGURE 2 — OUTPUT POWER versus INPUT POWER

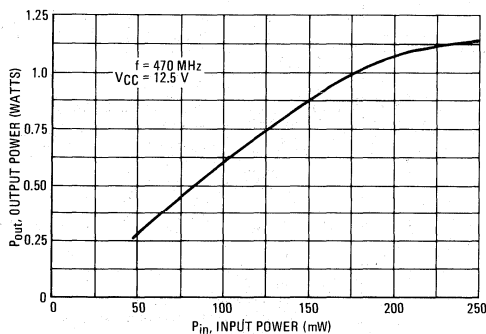


FIGURE 3 — CURRENT-GAIN — BANDWIDTH PRODUCT versus COLLECTOR CURRENT

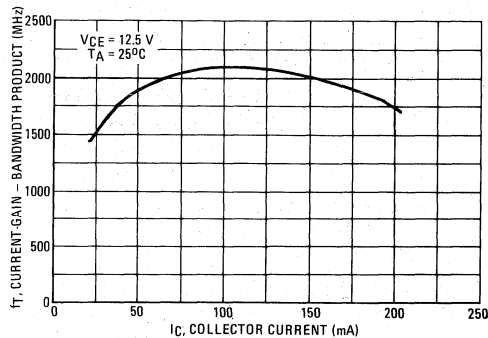


FIGURE 4 — OUTPUT CAPACITANCE versus COLLECTOR BASE VOLTAGE

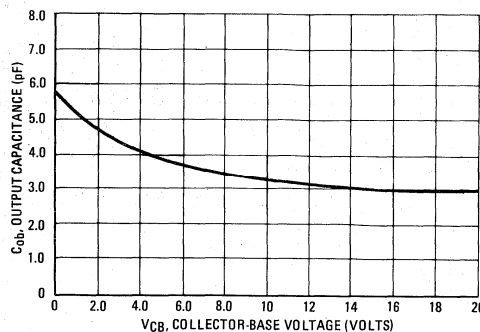
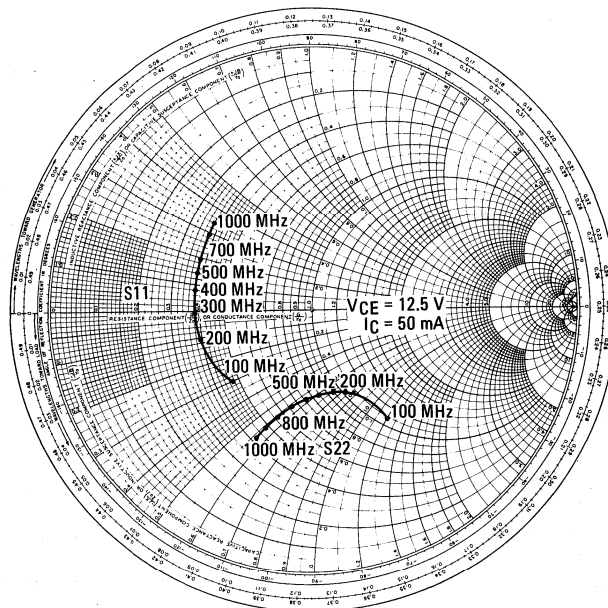
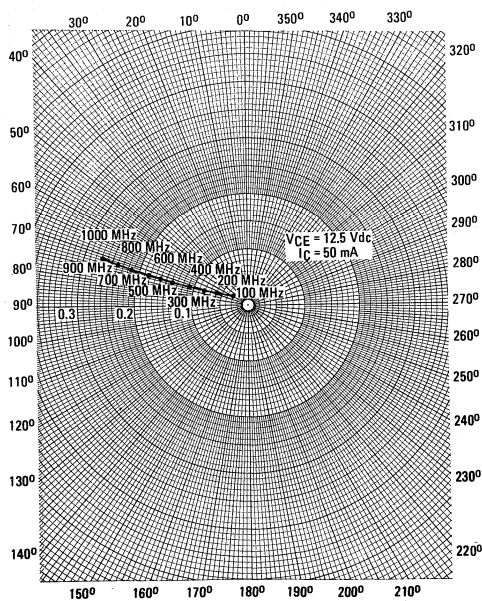
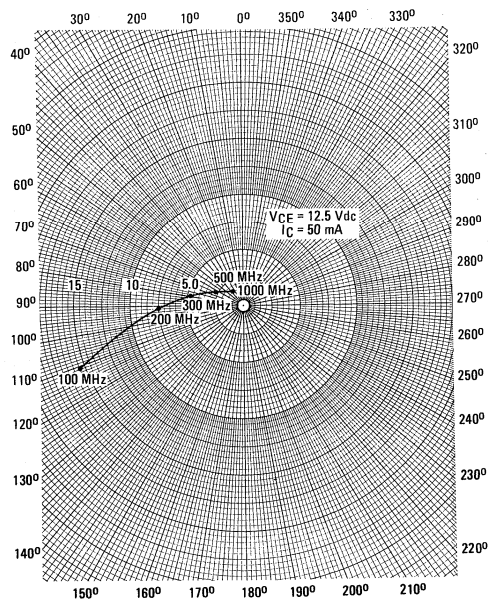


FIGURE 5 – S_{11} and S_{22} versus FREQUENCYFIGURE 6 – S_{12} versus FREQUENCYFIGURE 7 – S_{21} versus FREQUENCY

MRF517

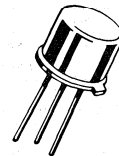
The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed specifically for broadband applications requiring low distortion characteristics. Specified for use in CATV distribution equipment.

- Specified +45 dBmV Output, 60 mA Distortion Characteristics –
Triple Beat = -72 dB (Max)
12 Channel Cross Modulation = -57 dB (Max)
Second Order = -60 dB (Max)
- Broadband Power Gain –
GPE = 10 dB (Typ)
- Broadband Noise Figure –
NF = 7.5 dB (Max) @ f = 300 MHz

**HIGH FREQUENCY
TRANSISTOR
NPN SILICON**

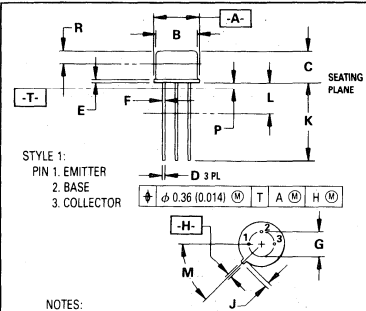
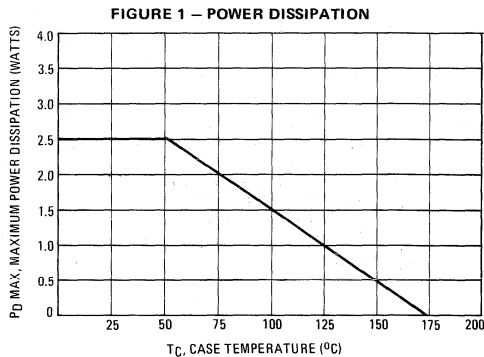


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage ($R_{BE} = 330 \Omega$)	V_{CER}	25	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current – Continuous	I_C	150	mAdc
Total Power Dissipation @ $T_C = 50^\circ\text{C}$ Derate above 50°C	P_D	2.5 0.02	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	+175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	$^\circ\text{C/W}$



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-04
TO-205AB
(TO-39)**

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $R_{BE} = 330\text{ Ohms}$)	$V_{(BR)CER}$	25	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{Adc}$, $I_E = 0$)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	100	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 60\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	40	—	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 60\text{ mAdc}$, $V_{CE} = 15\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	2200	2700	—	MHz
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	3.0	4.5	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($V_{CE} = 15\text{ Vdc}$, $I_C = 60\text{ mAdc}$, $f = 300\text{ MHz}$)	G_{pe}	—	10	—	dB
Broadband Noise Figure ($V_{CE} = 15\text{ Vdc}$, $I_C = 50\text{ mAdc}$, $f = 300\text{ MHz}$)	NF	—	—	7.5	dB
2nd Order Distortion ($V_{CE} = 15\text{ Vdc}$, $I_C = 60\text{ mAdc}$, $E_{out} = +45\text{ dBmV}$, Ch 2 + Ch G = 212.5 MHz)	IMD_2	—	—	-57	dB
NCTA Cross Modulation Distortion, 12 Ch's (2-13) ($V_{CE} = 15\text{ Vdc}$, $I_C = 60\text{ mAdc}$, $E_{out} = +45\text{ dBmV}$, Measured at Ch's 2 and 13)	XMD_{12}	—	—	-57	dB
Triple Beat Distortion, 3 Ch's ($V_{CE} = 15\text{ Vdc}$, $I_C = 60\text{ mAdc}$, $E_{out} = +45\text{ dBmV}$, Ch's (4 + 5 + A) = 265 MHz)	TB_3	—	—	-72	dB

FIGURE 2 — 40 to 330 MHz BROADBAND TEST CIRCUIT SCHEMATIC

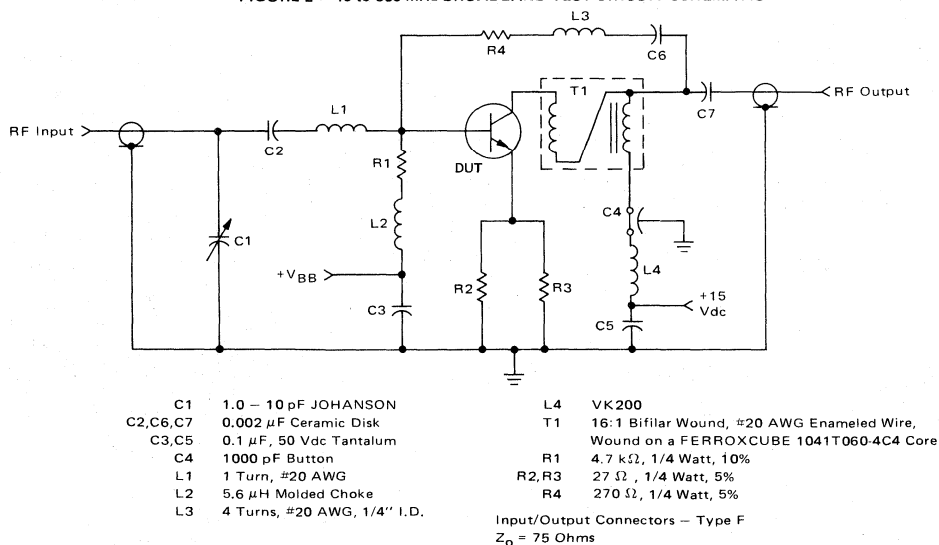


FIGURE 3 – TYPICAL RESPONSE CURVE
(See Figure 2)

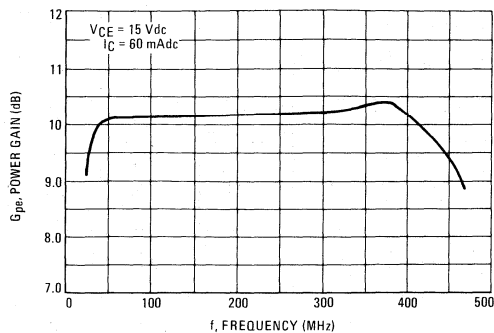


FIGURE 4 – COMMON-EMITTER POWER GAIN
versus FREQUENCY

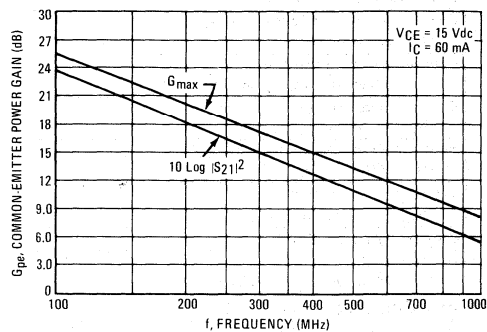


FIGURE 5 – CURRENT GAIN BANDWIDTH PRODUCT
versus COLLECTOR CURRENT

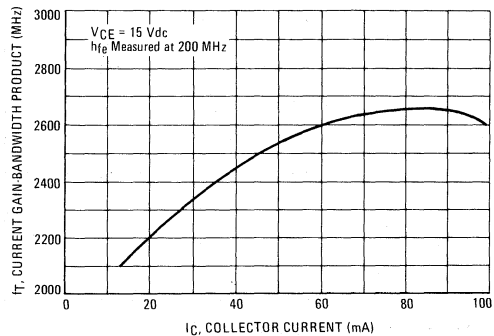


FIGURE 6 – INPUT CAPACITANCE versus
EMITTER-BASE VOLTAGE

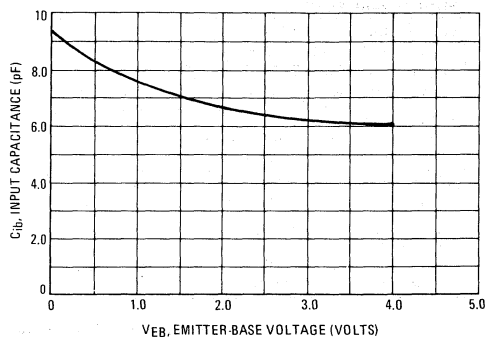


FIGURE 7 – OUTPUT CAPACITANCE versus
COLLECTOR-BASE VOLTAGE

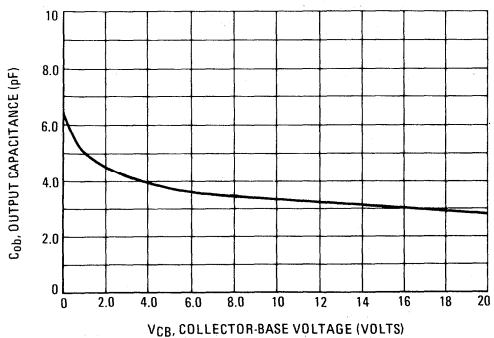


FIGURE 8 – BROADBAND NOISE FIGURE versus
COLLECTOR CURRENT

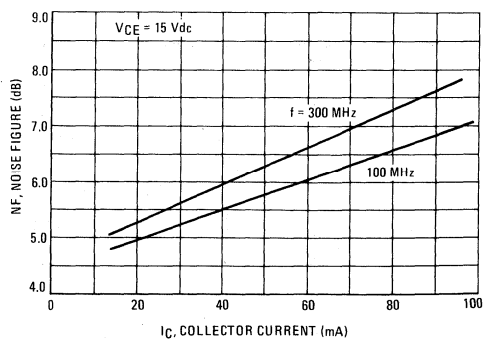


FIGURE 9 — 2nd ORDER DISTORTION ($f_1 \pm f_2$) versus COLLECTOR CURRENT

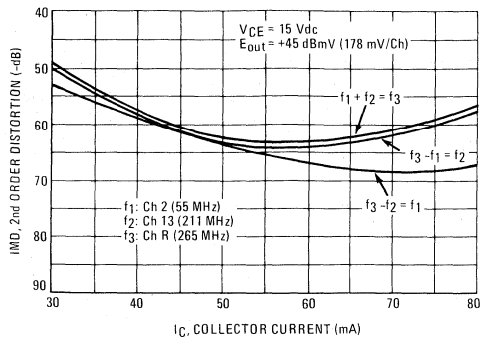


FIGURE 10 — 12-CHANNEL CROSS MODULATION DISTORTION versus COLLECTOR CURRENT

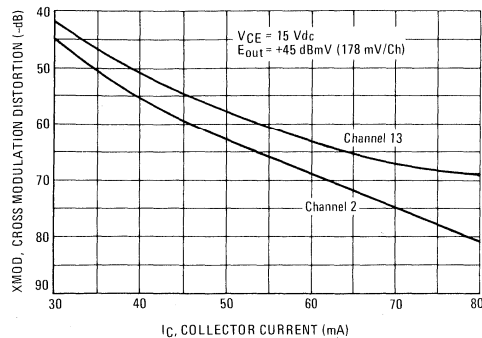


FIGURE 11 — DIN 45004 CROSS-MODULATION DISTORTION

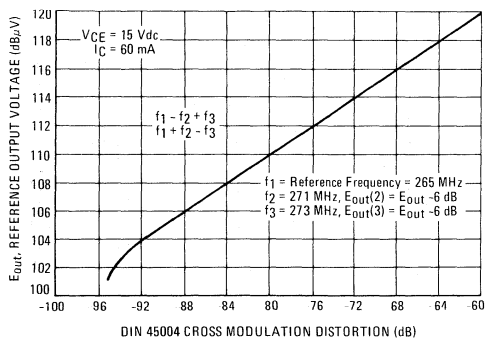


FIGURE 12 — TRIPLE BEAT DISTORTION ($f_1 + f_2 + f_3$) versus COLLECTOR CURRENT

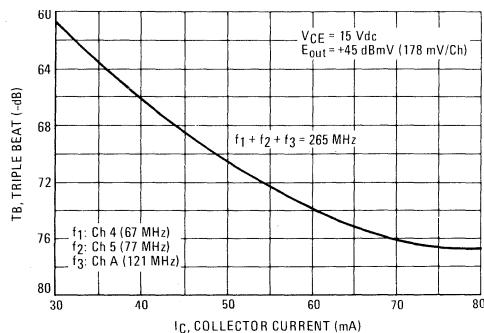
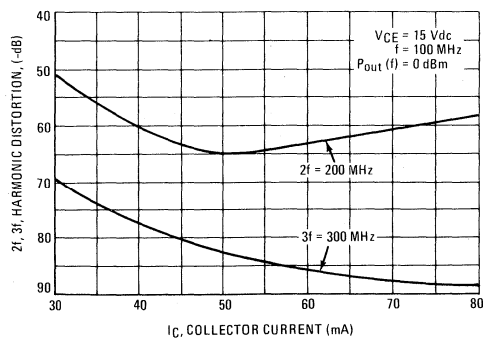


FIGURE 13 — HARMONIC DISTORTION ($2f$, $3f$) versus COLLECTOR CURRENT



V _{CE} (Volts)	I _C (mA)	Frequency (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
5	30	100	0.538	-152	12.821	100	0.043	49	0.381	-102
		200	0.546	-173	6.612	86	0.064	55	0.314	-121
		400	0.557	163	3.440	71	0.105	60	0.315	-132
		600	0.602	147	2.357	59	0.144	61	0.360	-140
		800	0.625	136	1.872	46	0.181	59	0.437	-143
		1000	0.626	120	1.614	34	0.211	57	0.482	-144
	60	100	0.532	-160	13.475	98	0.040	54	0.362	-111
		200	0.542	-178	6.850	86	0.063	60	0.314	-130
		400	0.558	160	3.586	72	0.109	63	0.313	-140
		600	0.602	145	2.475	60	0.151	62	0.353	-146
		800	0.619	134	1.962	48	0.190	59	0.423	-147
		1000	0.616	118	1.706	35	0.221	57	0.464	-147
	90	100	0.532	-163	13.530	98	0.038	57	0.354	-115
		200	0.545	179	6.908	85	0.063	62	0.313	-133
		400	0.558	159	3.607	72	0.111	64	0.312	-143
		600	0.604	145	2.489	61	0.153	63	0.352	-148
		800	0.620	133	1.982	48	0.193	59	0.419	-149
		1000	0.614	117	1.721	35	0.224	57	0.455	-148
10	30	100	0.500	-145	14.176	102	0.040	50	0.386	-87
		200	0.502	-170	7.358	87	0.059	55	0.304	-105
		400	0.512	164	3.819	71	0.097	61	0.304	-118
		600	0.559	149	2.593	59	0.133	62	0.356	-128
		800	0.583	137	2.033	46	0.166	60	0.442	-134
		1000	0.584	122	1.724	34	0.194	59	0.497	-137
	60	100	0.487	-154	14.977	100	0.037	55	0.353	-96
		200	0.498	-174	7.715	86	0.059	60	0.287	-114
		400	0.506	161	4.009	72	0.101	63	0.294	-125
		600	0.553	146	2.731	60	0.139	63	0.341	-133
		800	0.572	135	2.158	47	0.174	60	0.422	-137
		1000	0.569	119	1.835	35	0.202	58	0.475	-139
	90	100	0.486	-157	15.192	99	0.036	57	0.337	-98
		200	0.493	-176	7.764	86	0.058	61	0.280	-116
		400	0.508	160	4.043	72	0.101	64	0.287	-126
		600	0.555	145	2.761	60	0.141	63	0.336	-134
		800	0.574	134	2.184	47	0.176	60	0.417	-138
		1000	0.568	118	1.861	35	0.204	58	0.469	-139
15	30	100	0.465	-153	15.774	100	0.035	56	0.337	-88
		200	0.475	-174	8.091	86	0.056	61	0.274	-105
		400	0.487	161	4.209	71	0.097	64	0.284	-116
		600	0.532	146	2.863	59	0.133	63	0.337	-126
		800	0.551	135	2.249	47	0.167	60	0.425	-132
		1000	0.547	119	1.909	34	0.193	58	0.482	-135
	60	100	0.468	-150	15.650	101	0.036	54	0.354	-87
		200	0.475	-172	8.088	87	0.057	60	0.282	-104
		400	0.486	163	4.178	72	0.096	63	0.290	-116
		600	0.530	147	2.846	60	0.133	63	0.341	-126
		800	0.549	136	2.228	47	0.166	60	0.429	-132
		1000	0.547	120	1.887	34	0.192	59	0.487	-135
	90	100	0.487	-141	14.773	103	0.039	50	0.391	-80
		200	0.486	-167	7.724	87	0.057	55	0.303	-97
		400	0.491	166	3.986	71	0.093	61	0.306	-110
		600	0.537	150	2.694	59	0.127	62	0.359	-122
		800	0.565	138	2.108	45	0.159	60	0.448	-129
		1000	0.566	123	1.779	33	0.185	60	0.507	-134

The RF Line
PNP Silicon
High-Frequency Transistors

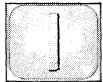




2

... designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching times.

- High Current Gain-Bandwidth Product — $f_T = 4.2$ GHz (Typ) @ $I_C = 50$ mAdc
- Low Noise Figure @ $f = 1$ GHz — $NF_{(matched)} = 2.8$ dB (Typ)
- High Power Gain — $G_{pe (matched)} = 11$ dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance
Lower Package Parasitics
Higher Gain
- Available In Both Standard Profile (MRF5211) and Low Profile (MRF5211L)
- Tape and Reel Packaging Options

MRF521
MRFC521
MRF522
MRF524
MRF5211,L

HIGH FREQUENCY
TRANSISTORS
PNP SILICON

		MRF521	MRF521	MRF522	MRF524	MRF5211,L	
							
		Chip	Macro-X Case 317-01 Style 2	Case 303-01 Style 1	Case 20-03 Style 10 (TO-72)	Case 318B-03 Style 1 (SOT-143)	
MAXIMUM RATINGS (Note 1)							
Ratings	Symbol	Values					Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	2.5	2.5	2.5	2.5	Vdc
Maximum Junction Temperature	T_{Jmax}	200	150	200	200	150	°C
Collector Current — Continuous	I_C	50	70	50	50	70	mA
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	—	—	—	0.2 1.14	0.58 4.64	Watts mW/°C
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ Derate above 75°C (Note 2)	P_D	0.75 —	0.75 10	0.62 5	—	0.58 7.7	Watts mW/°C
Storage Temperature	T_{stg}	−65 to +200	−65 to +150	−65 to +200	−65 to +200	−65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	—	—	—	870	216	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	—	100	200	—	130	°C/W

DEVICE MARKING

MRF5211 = 04

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 50$ μ Adc, $I_C = 0$)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 8$ Vdc, $I_E = 0$)	I_{CBO}	—	—	10	μ Adc

Notes 1. Voltages and currents for PNP transistors are given for magnitude information only. Polarity is assumed to be opposite that of an NPN transistor.

2. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain ($I_C = 30\text{ mA}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	25	—	125	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 6\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	Figure 1 C_{cb}	—	1	1.5	pF
Current Gain — Bandwidth Product ($V_{CE} = 8\text{ Vdc}$, $I_C = 50\text{ mA}$, $f = 1\text{ GHz}$)	Figure 7 f_T	—	4.2	—	GHz
FUNCTIONAL TESTS					
Power Gain at Minimum Noise Figure ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 500\text{ MHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 6 MRF524 MRF521/522/5211,L	G_{NFmin} 9 10	— 11	— —	dB
Noise Figure ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 500\text{ MHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 6 MRF524 MRF521/522/5211,L	NF_{min} — —	— 2.8	2.5 3.5	dB

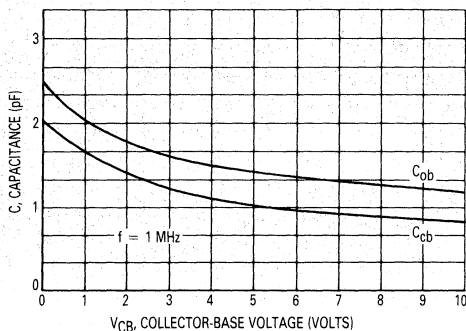
TYPICAL CHARACTERISTICS

Figure 1. Junction Capacitance versus Voltage

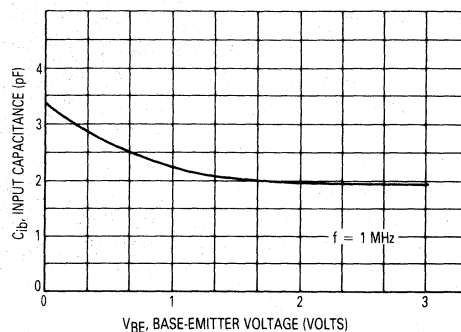


Figure 2. Input Capacitance versus Voltage

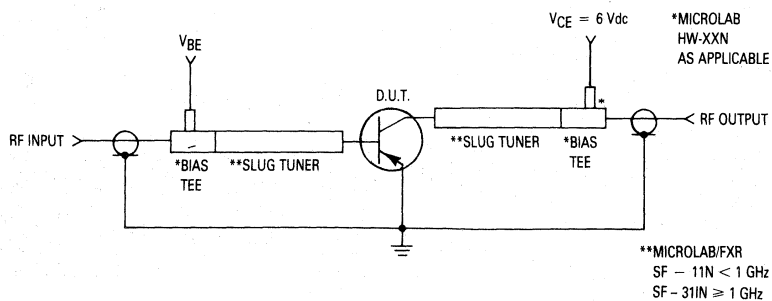


Figure 3. Functional Circuit Schematic

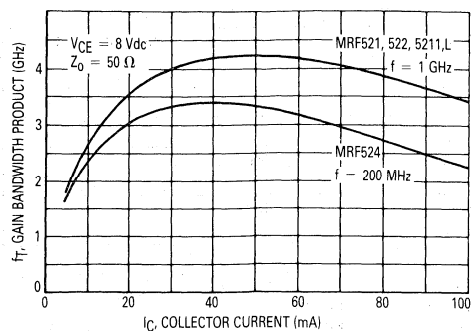


Figure 4. Gain-Bandwidth Product versus Current

GAIN AND NOISE FIGURE VERSUS FREQUENCY

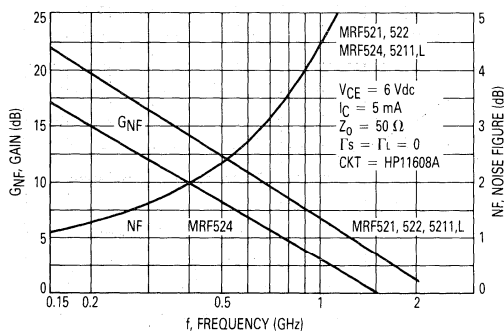


Figure 5. 50 Ohm System

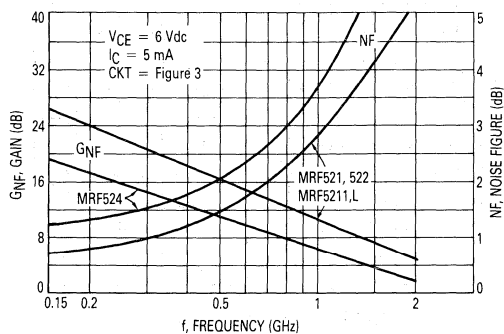


Figure 6. Tuned Circuit

GAIN AND NOISE FIGURE VERSUS CURRENT

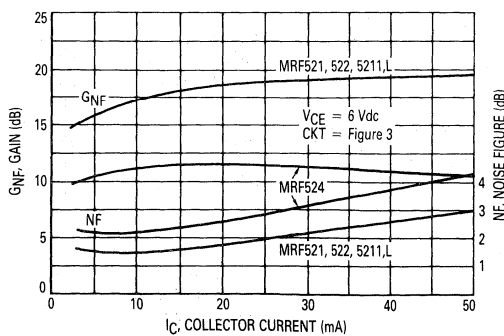


Figure 7. Tuned Circuit — Frequency 500 MHz

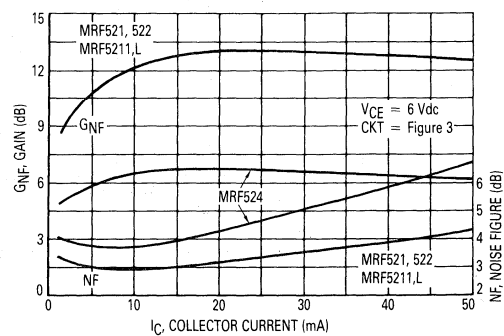
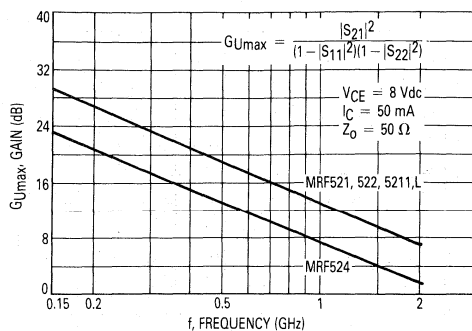


Figure 8. Tuned Circuit — Frequency 1 GHz

Figure 9. G_{Ummax} versus Current

MRF521 COMMON EMITTER S-PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle \phi$	$|S_{21}|$	$\angle \phi$	$|S_{12}|$	$\angle \phi$	$|S_{22}|$	$\angle \phi$
6	5	200	0.75	-116	7.6	117	0.06	36	0.59	-42
		500	0.75	-164	3.9	86	0.07	28	0.42	-51
		1000	0.74	165	2	63	0.08	37	0.37	-64
		1500	0.75	144	1.3	45	0.09	53	0.39	-85
		2000	0.74	124	1	32	0.14	61	0.43	-101
	10	200	0.71	-138	10.7	109	0.04	37	0.45	-54
		500	0.72	-175	4.7	82	0.06	40	0.29	-61
		1000	0.72	148	2.4	63	0.08	55	0.20	-73
		1500	0.72	140	1.6	47	0.11	63	0.28	-94
		2000	0.71	122	1.2	34	0.16	61	0.31	-108
	50	200	0.71	-172	12.9	100	0.02	59	0.26	-77
		500	0.72	170	5.3	78	0.05	68	0.15	-88
		1000	0.72	152	2.7	62	0.09	71	0.13	-99
		1500	0.72	136	1.8	46	0.13	70	0.17	-116
		2000	0.71	118	1.4	63	0.18	63	0.20	-123
8	5	200	0.77	-107	8.3	119	0.06	40	0.64	-38
		500	0.74	-163	4.1	88	0.07	28	0.45	-46
		1000	0.74	167	2.2	64	0.07	39	0.40	-58
		1500	0.74	146	1.4	47	0.08	54	0.42	-79
		2000	0.73	126	1.1	33	0.13	62	0.45	-95
	10	200	0.69	-133	11.5	111	0.04	39	0.49	-49
		500	0.71	-172	5.1	83	0.05	41	0.32	-55
		1000	0.71	161	2.6	64	0.07	56	0.28	-64
		1500	0.71	142	1.7	48	0.10	64	0.30	-85
		2000	0.70	123	1.3	34	0.15	63	0.33	-98
	50	200	0.67	-171	13.2	99	0.02	59	0.25	-70
		500	0.70	171	5.8	81	0.04	67	0.17	-74
		1000	0.69	151	2.9	62	0.08	72	0.15	-82
		1500	0.70	136	2	38	0.12	70	0.17	-100
		2000	0.68	117	1.5	33	0.17	63	0.20	-109

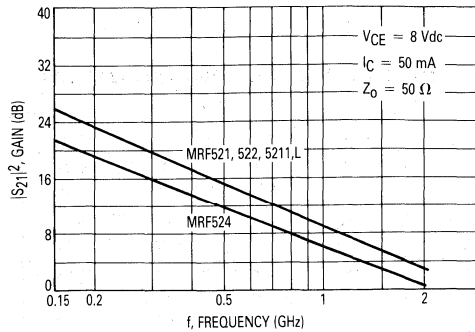


Figure 10. Insertion Gain versus Frequency

MRF522 COMMON EMITTER S-PARAMETERS

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	$\angle \phi$	|S21|	$\angle \phi$	|S12|	$\angle \phi$	|S22|	$\angle \phi$
6	5	200	0.77	-113	7.5	120	0.06	34	0.60	-40
		500	0.80	-157	3.9	90	0.07	18	0.42	-51
		1000	0.83	177	2	70	0.07	14	0.36	-63
		1500	0.84	164	1.3	52	0.06	17	0.37	-88
		2000	0.88	153	1	39	0.06	27	0.41	-106
	10	200	0.77	-138	10.4	112	0.04	32	0.47	-56
		500	0.82	-168	4.9	88	0.05	25	0.28	-65
		1000	0.85	173	2.5	71	0.05	31	0.23	-77
		1500	0.86	163	1.7	56	0.06	39	0.26	-100
		2000	0.88	153	1.3	45	0.07	47	0.30	-112
	50	200	0.81	-169	13.2	104	0.02	43	0.30	-88
		500	0.84	177	5.8	85	0.03	53	0.17	-112
		1000	0.87	166	3	71	0.04	63	0.13	-130
		1500	0.87	158	2	57	0.06	65	0.19	-138
		2000	0.90	149	1.5	47	0.08	66	0.21	-142
8	5	200	0.80	-109	8	121	0.06	36	0.64	-39
		500	0.81	-153	4.1	92	0.07	20	0.43	-46
		1000	0.83	-179	2.1	72	0.07	15	0.38	-58
		1500	0.85	168	1.4	55	0.06	18	0.39	-80
		2000	0.87	157	1.1	43	0.06	28	0.42	-95
	10	200	0.76	-133	11.1	113	0.04	33	0.49	-52
		500	0.80	-167	5.3	89	0.05	25	0.28	-60
		1000	0.83	174	2.7	71	0.05	31	0.23	-69
		1500	0.85	163	1.8	57	0.06	38	0.27	-91
		2000	0.87	153	1.4	46	0.07	46	0.30	-105
	50	200	0.76	-160	14.4	105	0.02	44	0.30	-86
		500	0.80	178	6.4	85	0.03	52	0.16	-110
		1000	0.84	164	3.2	70	0.04	62	0.16	-125
		1500	0.85	154	2.1	55	0.06	64	0.16	-140
		2000	0.88	145	1.7	45	0.08	62	0.19	-141

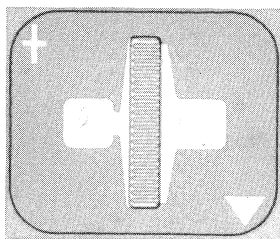
MRF524 COMMON EMITTER S-PARAMETERS

V _{CE} (V _{dC})	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
6	5	200	0.42	-98	5.8	109	0.07	57	0.65	-26
		400	0.29	-143	3.5	84	0.10	58	0.54	-29
		600	0.27	-175	2.5	71	0.13	60	0.50	-33
		800	0.27	166	2	60	0.17	61	0.47	-42
		1000	0.25	147	1.7	49	0.21	61	0.47	-49
	10	200	0.28	-111	7.3	100	0.06	64	0.54	-28
		400	0.21	-152	4.1	81	0.10	64	0.46	-28
		600	0.20	-179	2.9	69	0.14	63	0.41	-32
		800	0.20	167	2.3	59	0.19	61	0.39	-41
		1000	0.18	149	1.9	49	0.22	58	0.41	-47
	50	200	0.15	-136	8.1	92	0.06	73	0.42	-26
		400	0.13	-172	4.4	77	0.12	70	0.36	-25
		600	0.15	166	3.1	66	0.17	65	0.33	-28
		800	0.15	159	2.4	56	0.21	60	0.32	-38
		1000	0.13	143	2	47	0.25	55	0.32	-45
8	5	200	0.45	-93	6.1	109	0.06	57	0.67	-25
		400	0.30	-137	3.7	86	0.09	58	0.57	-27
		600	0.27	-167	2.6	72	0.12	60	0.51	-32
		800	0.26	174	2.1	61	0.15	60	0.49	-40
		1000	0.23	155	1.8	51	0.19	60	0.50	-47
	10	200	0.28	-100	7.5	101	0.06	65	0.57	-25
		400	0.18	-139	4.3	82	0.10	65	0.49	-26
		600	0.17	-171	3	70	0.13	64	0.45	-30
		800	0.16	174	2.3	60	0.18	61	0.43	-39
		1000	0.13	153	2	50	0.21	58	0.44	-45
	50	200	0.14	-107	8.3	94	0.06	72	0.47	-23
		400	0.10	-155	4.6	78	0.11	70	0.42	-23
		600	0.10	172	3.2	67	0.16	66	0.39	-26
		800	0.10	163	2.5	57	0.20	61	0.37	-36
		1000	0.09	144	2	47	0.24	57	0.37	-42

MRF5211,L COMMON EMITTER S-PARAMETERS

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
6	5	200	0.82	-114	7.9	118	0.07	35	0.59	-46
		500	0.81	-158	4	88	0.08	21	0.40	-54
		1000	0.79	175	2	67	0.08	21	0.37	-68
		1500	0.76	158	1.3	50	0.07	30	0.43	-82
		2000	0.74	143	1	38	0.08	47	0.47	-95
	10	200	0.78	-137	10.6	109	0.05	32	0.43	-63
		500	0.79	-168	4.9	84	0.06	28	0.26	-75
		1000	0.77	169	2.5	66	0.06	39	0.24	-87
		1500	0.74	155	1.6	50	0.08	49	0.29	-97
		2000	0.71	140	1.2	39	0.10	55	0.32	-106
	50	200	0.77	-167	13.1	99	0.02	45	0.26	-108
		500	0.77	176	5.7	80	0.04	57	0.18	-132
		1000	0.76	161	2.8	65	0.06	65	0.17	-142
		1500	0.73	149	1.9	51	0.08	67	0.19	-137
		2000	0.70	136	1.4	40	0.12	65	0.20	-137
8	5	200	0.82	-109	8.1	119	0.07	36	0.62	-43
		500	0.80	-154	4.2	90	0.08	22	0.42	-52
		1000	0.78	175	2.2	67	0.08	22	0.38	-65
		1500	0.75	159	1.4	50	0.07	31	0.43	-78
		2000	0.72	143	1	37	0.09	43	0.46	-89
	10	200	0.77	-132	11.2	110	0.05	33	0.45	-61
		500	0.77	-167	5.2	86	0.06	29	0.27	-70
		1000	0.76	169	2.6	67	0.06	39	0.25	-81
		1500	0.73	155	1.7	51	0.07	49	0.29	-90
		2000	0.70	140	1.3	39	0.10	54	0.31	-98
	50	200	0.75	-164	14.2	100	0.02	43	0.26	-101
		500	0.76	178	6.1	82	0.04	55	0.17	-121
		1000	0.75	163	3.1	67	0.06	64	0.15	-131
		1500	0.72	151	2	53	0.08	67	0.18	-126
		2000	0.70	139	1.5	42	0.11	68	0.19	-127

CHIP TOPOGRAPHY



Nominal Chip Size: 0.015" x 0.016" x 0.005"
 Front Metallization: Gold
 Back Metallization: Gold
 Emitter Base Bond Pad: 2.2 x 2.2 mil
 #Emitter Fingers: 22
 #Base Fingers: 23
 Emitter Diffusion: Ion-Implanted Arsenic

MRF525

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

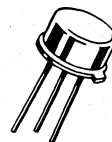
... designed specifically for broadband linear amplifier stages in the 100–500 MHz frequency range.

- Guaranteed Performance at 225–400 MHz, 26 Vdc
Minimum Gain = 13 dB
Maximum NF = 4.0 dB
- Third Order Intercept +35 dBm (Typ)
- Common Emitter TO-39 Type Package
- S-Parameter Characterization

100–500 MHz BROADBAND

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON

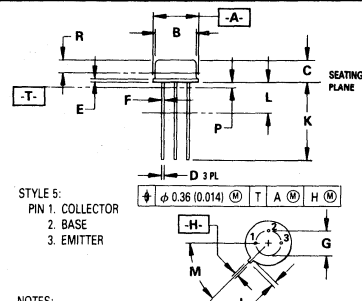


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage ($R_{BE} = 330 \Omega$)	V_{CER}	25	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	150	mA dc
Total Power Dissipation @ $T_A = 50^\circ\text{C}$ Derate above 50°C	P_D	2.5 0.017	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	+175	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	60	$^\circ\text{C/W}$



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

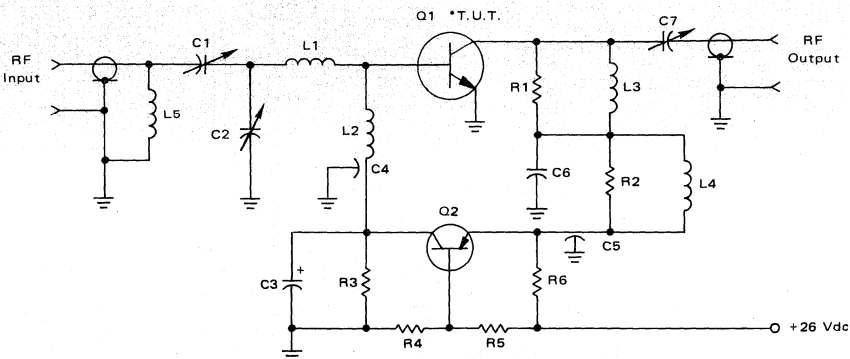
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-05
TO-206AF
(TO-39)**

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $R_{BE} = 330\text{ Ohms}$)	$V_{(BR)CER}$	25	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	100	μA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 80\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	60	—	175	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50\text{ mA}$, $V_{CE} = 20\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	2.2	2.5	—	GHz
Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	3.0	4.0	pF
FUNCTIONAL TEST — BROADBAND (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 26\text{ Vdc}$, $P_{in} = 0\text{ dBm}$, $f = 400\text{ MHz}$)	G_{PE}	13	14	—	dB
Broadband Noise Figure ($V_{CE} = 26\text{ Vdc}$, $f = 400\text{ MHz}$)	NF	—	—	4.0	dB

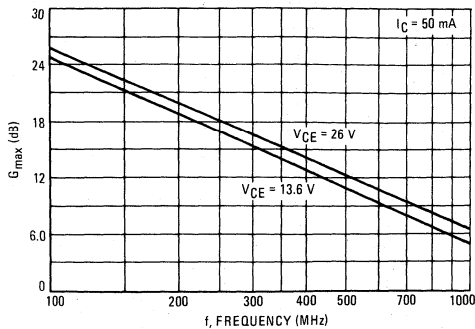
FIGURE 1 — 225 to 400 MHz BROADBAND TEST CIRCUIT SCHEMATIC



C1, C2 — 2.5–11 pF Erie Ceramic Variable
 C3 — 47 μF 6.0 Volt Electrolytic
 C4, C5 — 1000 pF Feedthru
 C6 — 470 pF Ceramic Chip
 C7 — 5.5–18 pF Erie Ceramic Variable
 R1 — 150 Ω 1/8 Watt Carbon
 R2 — 100 Ω 1/8 Watt Carbon
 R3, R4 — 10 k Ω 1/8 Watt Carbon
 R5 — 3.3 k Ω 1/8 Watt Carbon

R6 — 120 Ω 1/2 Watt Carbon
 L1 — 1 Turn #24, 0.125 mil ID
 L2, L4 — 0.47 μH Molded Choke
 L3 — 2 Turns #24, 0.125 mil ID
 L5 — 4 Turns #24, 0.125 mil ID
 Q2 — 2N2907A
 *Transistor Under Test
 $I_E = 47\text{ mA}$ (Nominal)

**FIGURE 2 – COMMON-EMITTER POWER GAIN (G_{max})
versus FREQUENCY**



**FIGURE 3 – CURRENT GAIN BANDWIDTH PRODUCT
versus COLLECTOR CURRENT**

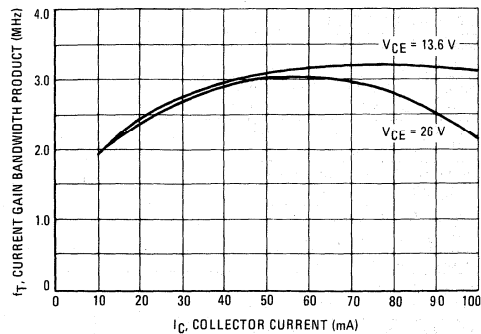
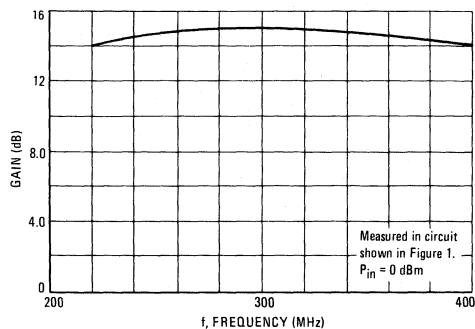


FIGURE 4 – BROADBAND AMPLIFIER RESPONSE



**FIGURE 5 – 1.0 dB GAIN COMPRESSION OUTPUT
versus FREQUENCY**

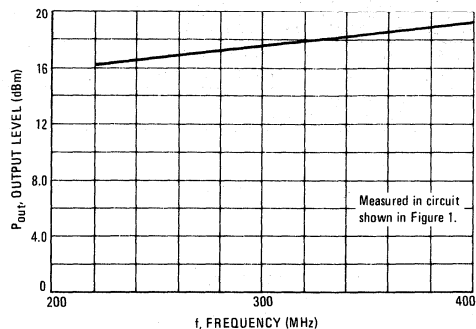
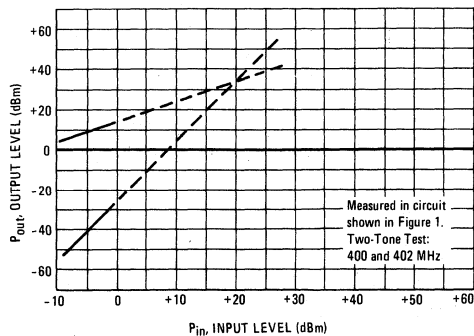


FIGURE 6 – THIRD ORDER INTERCEPT



S-PARAMETERS

VCE (Volts)	IC (mA)	Frequency (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
13.6	10	100	0.388	-111	12.318	107	0.032	61	0.597	-24
		200	0.331	-151	6.768	88	0.049	68	0.480	-25
		300	0.337	-171	4.650	77	0.072	73	0.443	-31
		400	0.344	176	3.580	68	0.096	78	0.442	-40
		500	0.349	166	2.889	59	0.125	80	0.459	-47
	20	100	0.287	-125	14.160	103	0.030	67	0.516	-24
		200	0.263	-160	7.585	86	0.053	73	0.414	-23
		300	0.275	-177	5.167	76	0.078	76	0.378	-30
		400	0.288	172	3.968	68	0.104	77	0.378	-38
		500	0.293	164	3.214	60	0.135	78	0.396	-45
	50	100	0.206	-140	15.745	99	0.029	74	0.446	-24
		200	0.208	-171	8.299	84	0.056	76	0.358	-21
		300	0.226	176	5.612	75	0.084	76	0.324	-27
		400	0.235	169	4.307	68	0.113	77	0.326	-36
		500	0.243	161	3.488	60	0.114	76	0.345	-42
	100	100	0.179	-151	15.931	98	0.029	77	0.430	-22
		200	0.187	-177	8.293	85	0.058	80	0.358	-19
		300	0.203	171	5.626	77	0.087	80	0.330	-25
		400	0.212	164	4.276	70	0.115	80	0.338	-33
		500	0.213	157	3.456	63	0.147	79	0.364	-39
26	10	100	0.454	-100	13.580	105	0.027	58	0.625	-15
		200	0.313	-138	7.339	88	0.040	67	0.552	-17
		300	0.291	-161	4.989	78	0.060	76	0.532	-23
		400	0.287	-175	3.826	70	0.080	84	0.544	-30
		500	0.287	173	3.096	63	0.106	89	0.570	-36
	20	100	0.313	-105	15.191	102	0.025	62	0.566	-14
		200	0.220	-144	8.086	87	0.044	73	0.509	-15
		300	0.213	-166	5.487	77	0.067	78	0.489	-20
		400	0.215	-178	4.204	71	0.092	83	0.498	-28
		500	0.214	170	3.404	64	0.116	86	0.523	-34
	50	100	0.165	-117	16.375	102	0.026	71	0.529	-14
		200	0.139	-157	8.695	87	0.048	78	0.471	-14
		300	0.151	-176	5.882	78	0.073	80	0.449	-20
		400	0.157	173	4.494	71	0.098	82	0.458	-27
		500	0.158	164	3.659	65	0.124	84	0.485	-32
	100	100	0.215	-147	13.156	103	0.023	72	0.602	-14
		200	0.212	-176	7.220	88	0.044	82	0.536	-17
		300	0.222	171	4.951	79	0.069	84	0.507	-24
		400	0.230	164	3.851	72	0.093	87	0.513	-31
		500	0.233	156	3.123	64	0.123	89	0.534	-36

MRF531

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed for high voltage and high current f_T switching applications. These devices are also ideal for CRT drivers.

- High Collector-Emitter Breakdown Voltage —
 $V_{(BR)CEO} = 100 \text{ Vdc (Min) @ } I_C = 10 \text{ mAdc}$
- High Current-Gain — Bandwidth Product —
 $f_T = 800 \text{ MHz (Typ) @ } I_C = 50 \text{ mAdc}$
- Characterized with Safe Operating Area (SOA) Curves

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	100	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	2.5 14	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	100	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 75 \text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	10	μAdc

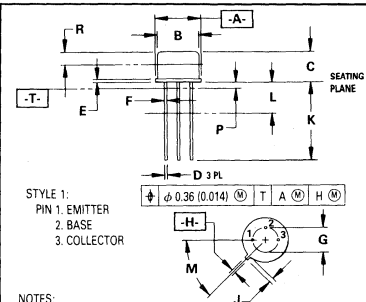
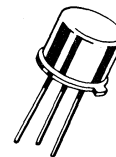
ON CHARACTERISTICS

DC Current Gain ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)	h_{FE}	25	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}$, $I_B = 1.0 \text{ mAdc}$)	$V_{CE(sat)}$	—	—	1.0	Vdc

DYNAMIC CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 50 \text{ mAdc}$, $V_{CE} = 25 \text{ Vdc}$, $f = 100 \text{ MHz}$)	f_T	500	800	—	MHz
Output Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	—	4.0	pF
Input Capacitance ($V_{BE} = 3.0 \text{ Vdc}$, $I_C = 0$, $f = 1.0 \text{ MHz}$)	C_{ib}	—	9.0	—	pF

**HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.49	0.016	0.019
G	5.08 BSC 0.200 BSC			
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC 45° BSC			
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-04
TO-205AD
(TO-39)**

FIGURE 1 – CURRENT-GAIN – BANDWIDTH PRODUCT

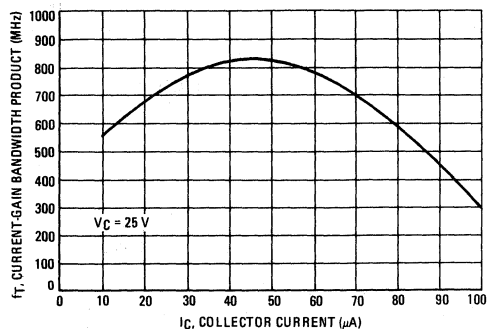


FIGURE 2 – INPUT CAPACITANCE

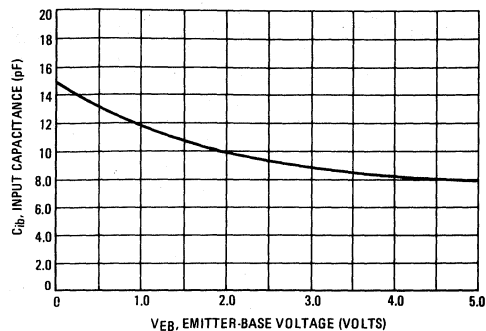


FIGURE 3 – OUTPUT CAPACITANCE

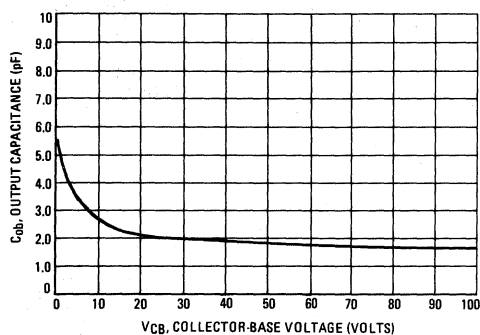
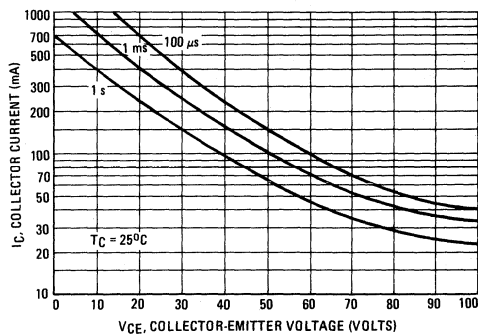


FIGURE 4 – DC SAFE OPERATING AREA



The RF Line

NPN Silicon

High Frequency Transistors

... designed primarily for high frequency common base amplifiers used in medium and high resolution color video display monitors.

- High Collector-Base Breakdown Voltage $V_{(BR)CBO} = 120$ V (Min)
- Stripline Opposed Base Construction
- Common Base Insertion Gain = 5.5 dB (Typ)
- Package Options for Low Cost (MRF542), High Power Dissipation (MRF548)
- **Die Source Same as MRF544**
- Emitter Ballasted for Improved Ruggedness

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	70	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector-Current — Continuous	I_C	400	mA _{dc}
Operating Junction Temperature	T_J	150 200	°C °C
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ (1,2)	P_D	3 5 40	Watts mW/°C
Derate above 75°C			
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1$ mA _{dc} , $I_E = 0$)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mA _{dc} , $I_E = 0$)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA _{dc} , $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 80$ Vdc, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	100	μA _{dc}
Collector Cutoff Current ($V_{CB} = 80$ Vdc, $I_E = 0$)	I_{CBO}	—	—	20	μA _{dc}

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA _{dc} , $V_{CE} = 10$ Vdc)	h_{FE}	15	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	2.9	—	pF
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	2	2.5	pF
Input Capacitance ($V_{EB} = 3$ Vdc, $f = 1$ MHz)	C_{ib}	—	12.5	—	pF

FUNCTIONAL TESTS

Common Base Gain ($V_{CB} = 10$ V, $I_C = 100$ mA, $f = 250$ MHz)	$ S_{21} ^2$	4.5	5.5	—	dB
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(1) T_C , Case temperature measured on collector lead immediately adjacent to body of package.

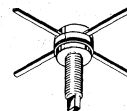
(2) The MRF542 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques in PowerMacro Transistor," discusses methods of mounting and heatsinking.

MRF542
MRF548

HIGH FREQUENCY
TRANSISTORS
NPN SILICON



MRF542
CASE 317D-02, STYLE 3
PLASTIC



MRF548
CASE 244A-01, STYLE 3
(TO-117)
CERAMIC

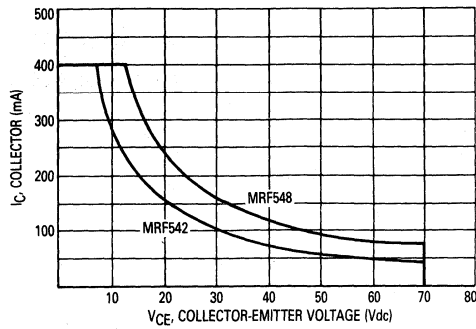


Figure 1. Safe Operating Area

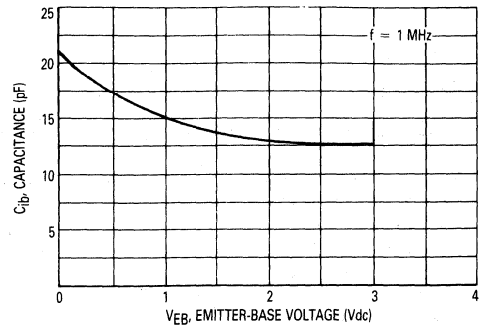


Figure 2. Input Capacitance versus Voltage

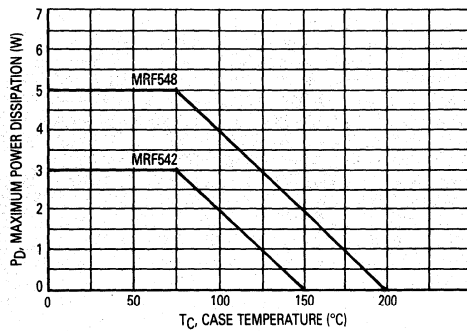


Figure 3. Power Dissipation versus Temperature

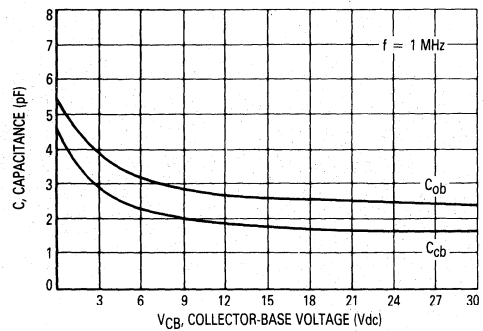


Figure 4. Junction Capacitance versus Voltage

The RF Line

PNP Silicon

High Frequency Transistors

... designed primarily for high frequency common base amplifiers used in medium and high resolution color video display monitors.

- High Collector-Base Breakdown Voltage $V_{(BR)CBO} = 100 \text{ V (Min)}$
- Stripline Opposed Base Construction
- Common Base Insertion Gain $\approx 5.5 \text{ dB (Typ)}$
- Package Options for Low Cost (MRF543), High Power Dissipation (MRF549)
- **Die Source Same As MRF545**
- Emitter Ballasted for Improved Ruggedness

MAXIMUM RATINGS (Note 1)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	70	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector-Current — Continuous	I_C	400	mA dc
Operating Junction Temperature	T_J	150 200	°C °C
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ (2,3)	P_D	3 5 40	Watts mW/°C
Derate above 75°C			
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted. Note 1.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1 \text{ mA dc}, I_E = 0$)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mA dc}, I_E = 0$)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA dc}, I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 80 \text{ Vdc}, V_{BE} = 0, T_C = 25^\circ\text{C}$)	I_{CES}	—	—	100	$\mu\text{A dc}$
Collector Cutoff Current ($V_{CB} = 80 \text{ Vdc}, I_E = 0$)	I_{CBO}	—	—	20	$\mu\text{A dc}$

ON CHARACTERISTICS

DC Current Gain ($I_C = 50 \text{ mA dc}, V_{CE} = 10 \text{ Vdc}$)	h_{FE}	15	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1 \text{ MHz}$)	C_{ob}	—	2.8	—	pF
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 1 \text{ MHz}$)	C_{cb}	—	2	2.5	pF
Input Capacitance ($V_{EB} = 3 \text{ Vdc}, f = 1 \text{ MHz}$)	C_{ib}	—	10.5	—	pF

FUNCTIONAL TESTS

Common Base Gain ($V_{CB} = 10 \text{ V}, I_C = 100 \text{ mA}, f = 250 \text{ MHz}$)	$ S_{21} ^2$	4.5	5.5	—	dB
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Notes 1. Voltages and currents for PNP transistors are given for magnitude information only.

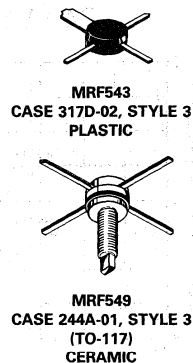
Polarity is assumed to be opposite that of an NPN transistor.

2. T_C , Case temperature for MRF543 measured on collector lead immediately adjacent to body of package.

3. The MRF543 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques in PowerMacro Transistor," discusses methods of mounting and heatsinking.

MRF543
MRF549

HIGH FREQUENCY
TRANSISTORS
PNP SILICON



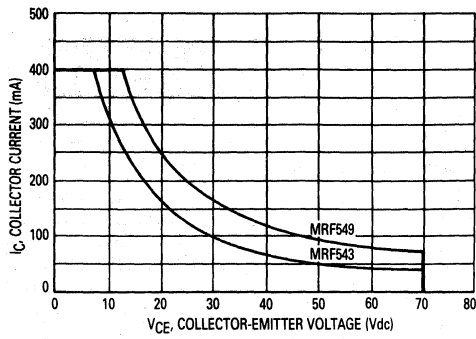


Figure 1. Safe Operating Area

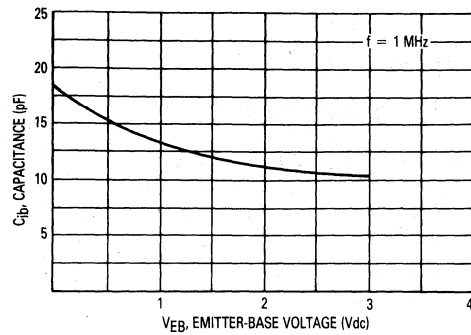


Figure 2. Input Capacitance versus Voltage

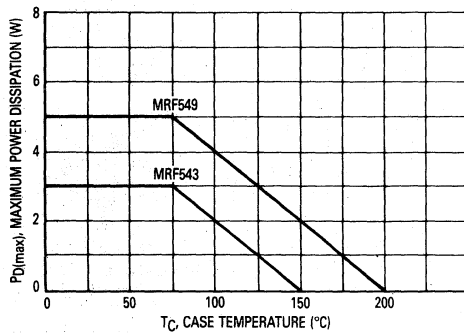


Figure 3. Power Dissipation versus Temperature

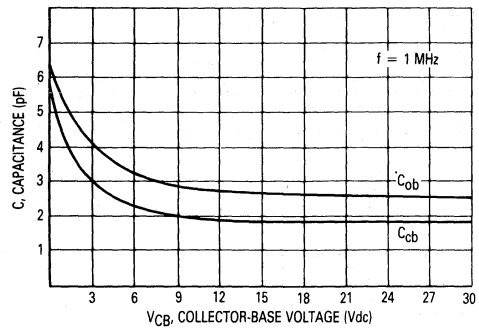


Figure 4. Junction Capacitance versus Voltage

The RF Line NPN Silicon High Frequency Transistors

... designed for high-frequency and medium and high resolution color video display monitors.

- Emitter Ballasting for Improved Ruggedness
- High Power Gain — $G_U(\text{max}) = 16.5 \text{ dB (Typ) @ } f = 500 \text{ MHz}$
- Ion Implanted
- High Collector Base Breakdown Voltage — $V_{(BR)CBO}, 120 \text{ V (Min)}$
- High f_T — 1400 MHz
- State-of-the-Art Technology Fine Line Geometry
- Gold Top Metallization
- Silicon Nitride Passivation

MAXIMUM RATINGS

Rating	Symbol	MRFC544	MRF544	Unit
Collector-Emitter Voltage	V_{CEO}	70	70	Vdc
Collector-Base Voltage	V_{CBO}	120	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	3	Vdc
Collector Current — Continuous	I_C	400	400	mA
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ Derate above 75°C	P_D	5 $T_{J\text{max}} = 200^\circ\text{C}$	3.5 28	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	-65 to +200	°C

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 1 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \mu\text{A}$, $I_E = 0$)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100 \mu\text{A}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 80 \text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	100	μA
Collector Cutoff Current ($V_{CB} = 80 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	20	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50 \text{ mA}$, $V_{CE} = 10 \text{ Vdc}$)	h_{FE}	15	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	3	—	pF
Junction Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{cb}	—	1.8	2.5	pF
Input Capacitance ($V_{EB} = 3 \text{ Vdc}$, $I_C = 0$, $f = 1 \text{ MHz}$)	C_{ib}	—	9	—	pF
Current Gain-Bandwidth Product ($I_C = 50 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 250 \text{ MHz}$)	f_T	1000	1400	—	MHz

FUNCTIONAL TESTS

Maximum Available Gain ($I_C = 50 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 250 \text{ MHz}$)	G_{max}	—	16.5	—	dB
Insertion Gain ($I_C = 50 \text{ mA}$, $V_{CE} = 10 \text{ V}$, $f = 250 \text{ MHz}$)	$|S_{21}|^2$	—	13	—	dB

MRF544 MRFC544

$f_T = 1400 \text{ MHz (Typ)}$
@ 50 mA
**HIGH FREQUENCY
TRANSISTORS**



MRF544
CASE 79-04
STYLE 1
TO-205AD
(TO-39)



CHIP
MRFC544

TYPICAL CHARACTERISTICS

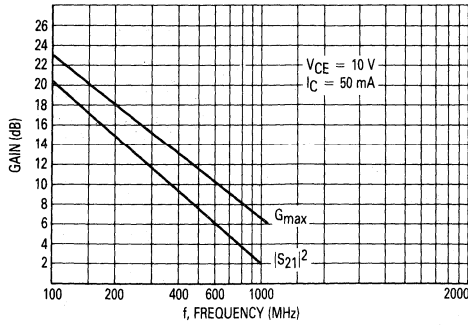


Figure 1. Power Gain versus Frequency

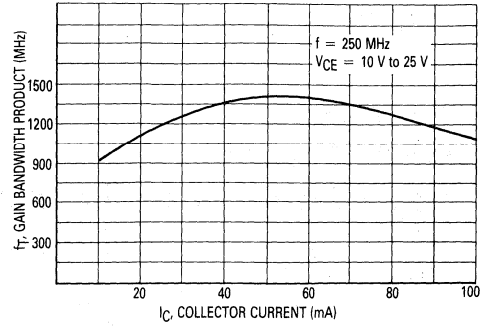


Figure 2. Gain-Bandwidth Product versus Collector Current

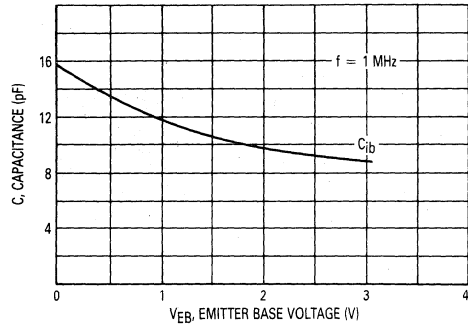


Figure 3. C_{ib} Input Capacitance versus Voltage

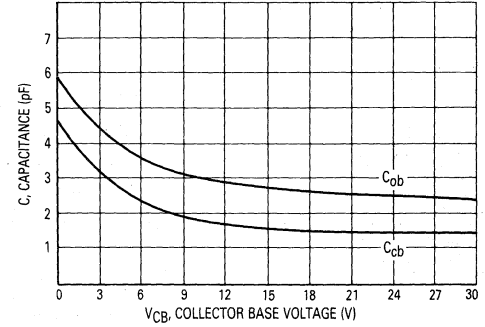


Figure 4. Junction Capacitance versus Voltage

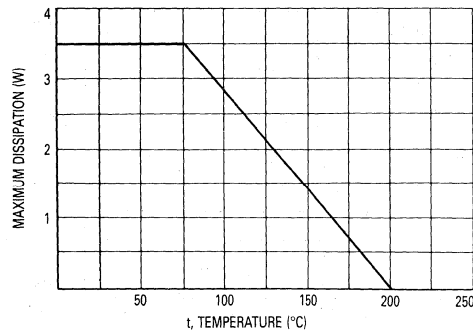


Figure 5. Dissipation versus Temperature

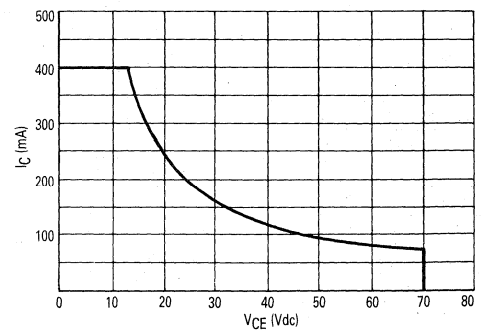


Figure 6. Safe Operating Area

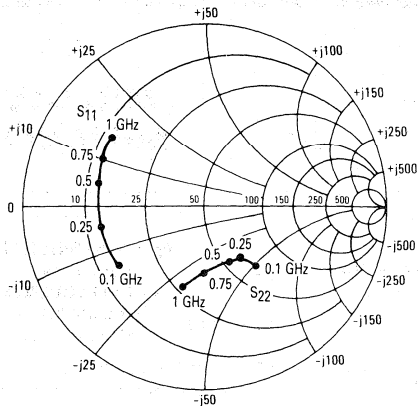


Figure 7. Input/Output Reflection Coefficient
versus Frequency (GHz)
 $V_{CE} = 10 \text{ V}$ $I_C = 50 \text{ mA}$

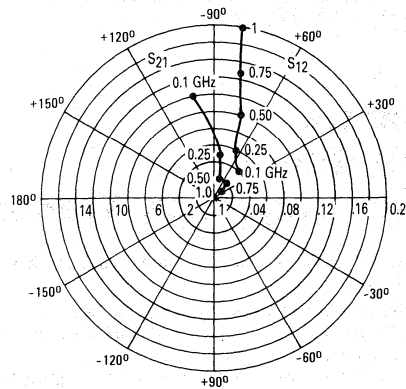


Figure 8. Forward/Reverse Transmission
Coefficients versus Frequency (GHz)
 $V_{CE} = 10 \text{ V}$ $I_C = 50 \text{ mA}$

COMMON EMITTER S-PARAMETERS

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
10	25	100	0.59	-138	11.71	106	0.04	50	0.48	-43
		250	0.59	-167	4.64	85	0.06	61	0.38	-50
		500	0.61	174	2.30	67	0.10	75	0.37	-66
		750	0.66	166	1.52	53	0.15	80	0.42	-89
		1000	0.66	157	1.17	43	0.20	82	0.50	-104
	50	100	0.58	-147	12.38	102	0.04	50	0.43	-48
		250	0.58	-171	4.85	83	0.06	63	0.34	-52
		500	0.60	170	2.43	66	0.10	74	0.33	-67
		750	0.64	163	1.61	52	0.15	78	0.39	-91
		1000	0.64	155	1.24	43	0.21	79	0.46	-105
	80	100	0.60	-151	12.15	101	0.03	49	0.39	-47
		250	0.60	-173	4.76	81	0.05	64	0.34	-55
		500	0.62	170	2.35	65	0.10	74	0.35	-72
		750	0.66	162	1.53	50	0.14	78	0.43	-96
		1000	0.65	154	1.16	40	0.20	78	0.51	-108
25	25	100	0.59	-133	12.77	110	0.03	44	0.53	-34
		250	0.59	-164	5.06	86	0.05	62	0.46	-42
		500	0.60	177	2.48	67	0.08	78	0.45	-60
		750	0.64	168	1.59	52	0.12	84	0.50	-83
		1000	0.66	159	1.20	43	0.17	87	0.57	-99
	50	100	0.56	-142	13.25	103	0.03	49	0.50	-35
		250	0.56	-169	5.21	82	0.05	64	0.44	-42
		500	0.58	172	2.60	64	0.09	76	0.43	-59
		750	0.62	163	1.68	50	0.13	82	0.48	-82
		1000	0.63	155	1.28	40	0.18	83	0.55	-97
	80	100	0.58	-143	13.87	102	0.03	52	0.54	-33
		250	0.57	-172	5.19	80	0.05	63	0.47	-39
		500	0.59	170	2.55	62	0.08	77	0.46	-58
		750	0.64	162	1.65	48	0.13	82	0.50	-81
		1000	0.64	154	1.24	37	0.18	83	0.57	-97

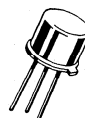
The RF Line **PNP Silicon** **High Frequency Transistors**

... designed for high-frequency and medium and high resolution color video display monitors.

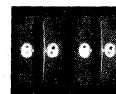
- Emitter Ballasting for Improved Ruggedness
- High Power Gain — $G_{U(max)} = 15.5 \text{ dB (Typ) @ } f = 250 \text{ MHz}$
- Ion Implanted
- High Collector Base Breakdown Voltage — $V_{(BR)CBO}, 100 \text{ V (Min)}$
- High f_T — 1250 MHz (Typ)
- State-of-the-Art Technology
 - Fine Line Geometry
 - Gold Top Metallization
 - Silicon Nitride Passivation

MRF545
MRFC545

$f_T = 1250 \text{ MHz (TYP.)}$
 @ 50 mA
HIGH FREQUENCY
TRANSISTORS
PNP SILICON



MRF545
CASE 79-04
STYLE 1
TO-205AD
(TO-39)



CHIP
MRFC545

MAXIMUM RATINGS (Note 1)

Rating	Symbol	MRFC545	MRF545	Unit
Collector-Emitter Voltage	V_{CEO}	70	70	Vdc
Collector-Base Voltage	V_{CBO}	100	100	Vdc
Emitter-Base Voltage	V_{EBO}	3	3	Vdc
Collector-Current — Continuous	I_C	400	400	mA dc
Operating Junction Temperature	T_J	200	200	°C
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ Derate above 75°C	P_D	5 $T_{Jmax} = 200^\circ\text{C}$	3.5 28	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	-65 to +200	°C

Note 1. Voltages and currents for PNP transistors are given for magnitude information only. Polarity is assumed to be opposite that of an NPN transistor.

ELECTRICAL CHARACTERISTICS (Note 1, $T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 80\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	100	μAdc
Collector Cutoff Current ($V_{CB} = 80\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	20	μAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	15	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	3.2	—	pF
Junction Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{cb}	—	2	2.5	pF
Input Capacitance ($V_{EB} = 3\text{ Vdc}$, $I_C = 0$, $f = 1\text{ MHz}$)	C_{ib}	—	10	—	pF
Current Gain-Bandwidth Product ($I_C = 50\text{ mA}$, $V_{CE} = 25\text{ V}$, $f = 250\text{ MHz}$)	f_T	1000	1250	—	MHz

FUNCTIONAL TESTS

Maximum Available Gain ($I_C = 50\text{ mA}$, $V_{CE} = 25\text{ V}$, $f = 250\text{ MHz}$)	G_{max}	—	15.5	—	dB
Insertion Gain ($I_C = 50\text{ mA}$, $V_{CE} = 25\text{ V}$, $f = 250\text{ MHz}$)	$|S_{21}|^2$	—	12.7	—	dB

Note 1. Voltages and currents for PNP transistors are given for magnitude information only.
Polarity is assumed to be opposite that of an NPN transistor.

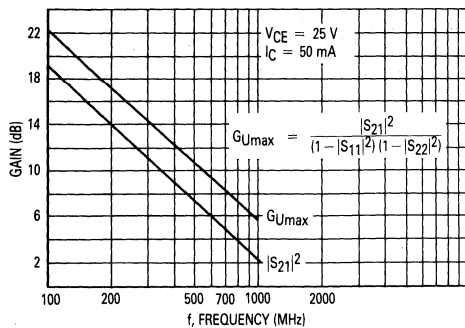


Figure 1. Power Gain versus Frequency

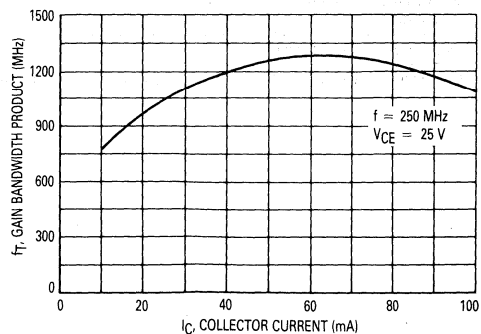


Figure 2. Gain-Bandwidth Product versus Collector Current

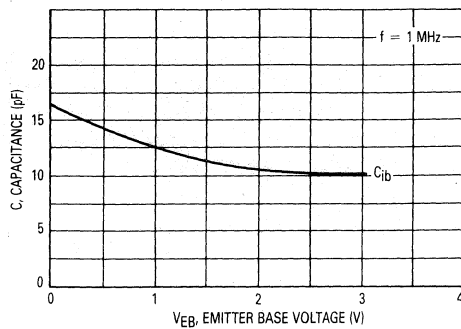


Figure 3. Input Capacitance versus Voltage

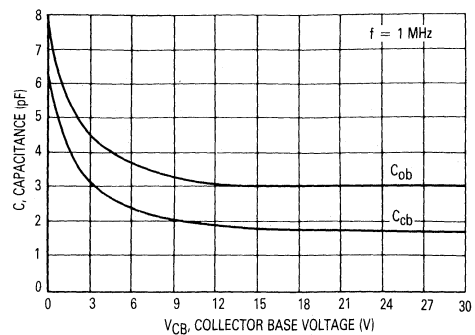


Figure 4. Junction Capacitance versus Voltage

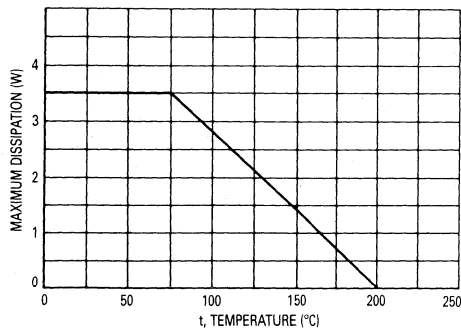


Figure 5. Dissipation versus Temperature

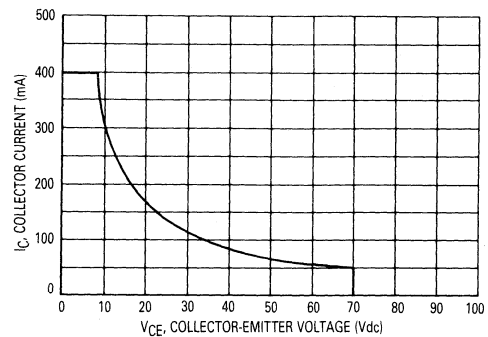


Figure 6. Safe Operating Area

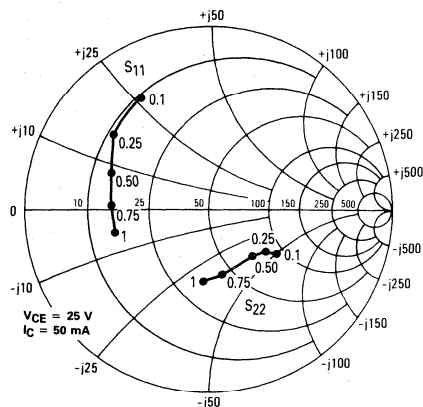


Figure 7. Input/Output Reflection Coefficient versus Frequency (GHz)

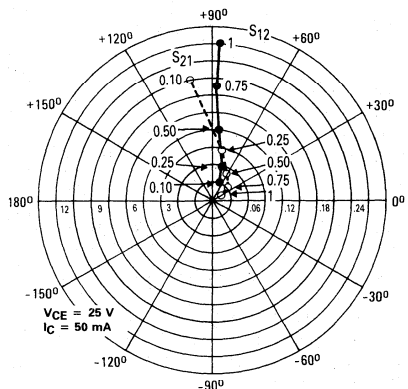


Figure 8. Forward/Reverse Transmission Coefficients versus Frequency

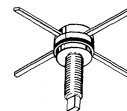
COMMON EMITTER S-PARAMETERS

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
10	25	100	0.60	-161	8.7	101	0.03	57	0.47	-34
		250	0.61	-180	3.6	81	0.06	74	0.42	-39
		500	0.66	163	1.9	62	0.12	88	0.38	-56
		750	0.72	154	1.3	50	0.19	91	0.40	-87
		1000	0.75	143	1.0	41	0.29	89	0.46	-102
	50	100	0.61	-169	8.8	99	0.03	64	0.43	-36
		250	0.62	177	3.7	80	0.06	79	0.38	-40
		500	0.66	161	1.9	63	0.13	88	0.35	-56
		750	0.72	153	1.3	50	0.20	89	0.36	-86
		1000	0.74	142	1.0	41	0.29	87	0.42	-102
	100	100	0.67	-178	5.6	94	0.03	68	0.40	-26
		250	0.70	170	2.3	74	0.07	81	0.36	-37
		500	0.71	155	1.2	54	0.16	89	0.39	-61
		750	0.76	142	0.9	42	0.27	87	0.40	-92
		1000	0.82	128	0.7	37	0.39	81	0.43	-117
25	25	100	0.55	-155	9.9	102	0.03	58	0.49	-32
		250	0.57	-176	4.2	82	0.06	72	0.43	-36
		500	0.61	165	2.1	64	0.11	87	0.38	-50
		750	0.68	156	1.4	51	0.18	90	0.41	-79
		1000	0.70	144	1.1	43	0.27	89	0.45	-96
	50	100	0.53	-162	10.6	101	0.03	62	0.44	-35
		250	0.55	-180	4.4	82	0.06	75	0.39	-38
		500	0.59	162	2.3	65	0.12	85	0.34	-50
		750	0.65	154	1.5	51	0.19	88	0.36	-78
		1000	0.67	143	1.2	43	0.27	86	0.40	-95
	100	100	0.48	-169	9.3	98	0.03	68	0.43	-27
		250	0.53	174	3.9	79	0.07	79	0.37	-33
		500	0.54	159	2.1	61	0.15	85	0.40	-52
		750	0.60	146	1.5	47	0.24	85	0.39	-77
		1000	0.65	132	1.1	37	0.34	81	0.41	-99

The RF Line
NPN Silicon
High Frequency Transistor

MRF546

**HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



CASE 244A-01, STYLE 3

... designed for high current, high frequency common base amplifiers used in medium and high resolution color video display monitors.

- Stripline Opposed Base Construction
- Die Source 2X Common Base MRF548
- Common Base Insertion Gain = 6 dB (Typ)
- High Collector-Base Breakdown Voltage $V_{(BR)CBO} = 120$ Vdc (Min)
- Emitter Ballasted For Improved Ruggedness
- Gold Top Metallization
- Silicon Nitride Passivation

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	70	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector-Current — Continuous	I_C	600	mAdc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation (at $T_C = 75^\circ\text{C}$ Derate above 75°C)	P_D	9 72	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	13.9	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 2$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.2$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.2$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 80$ Vdc, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	200	μAdc
Collector Cutoff Current ($V_{CB} = 80$ Vdc, $I_E = 0$)	I_{CBO}	—	—	40	μAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	15	—	200	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	5	—	pF
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	3.6	4.5	pF
Input Capacitance ($V_{EB} = 3$ Vdc, $f = 1$ MHz)	C_{ib}	—	26	—	pF

FUNCTIONAL TESTS

Common Base Gain ($V_{CB} = 10$ V, $I_C = 200$ mA, $f = 250$ MHz)	$ S_{21} ^2$	4.5	6	—	dB
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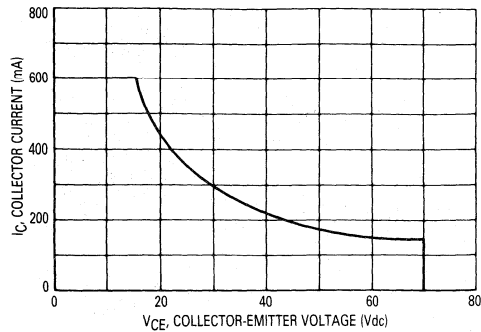


Figure 1. Safe Operating Area

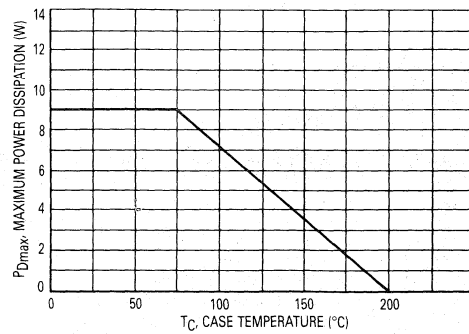


Figure 2. Power Dissipation versus Temperature

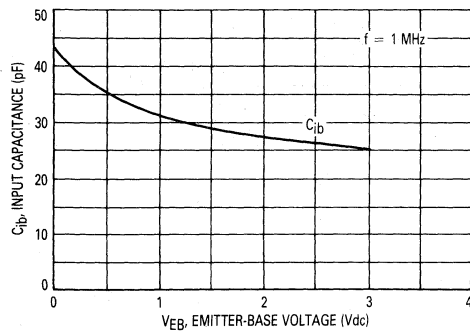


Figure 3. Input Capacitance versus Voltage

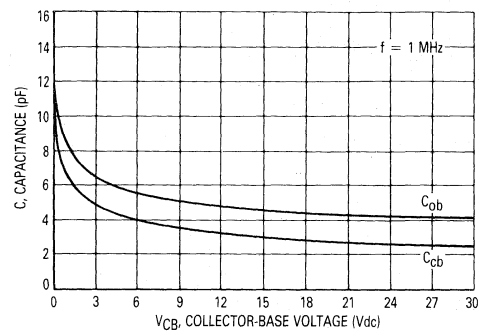
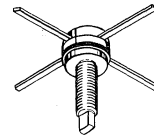


Figure 4. Junction Capacitance versus Voltage

The RF Line
PNP Silicon
High Frequency Transistor

MRF547

**HIGH FREQUENCY
TRANSISTOR
PNP SILICON**



CASE 244A-01, STYLE 2

... designed for high-current, high-frequency common base amplifiers used in medium and high resolution color video display monitors.

- Stripline Opposed Base Construction
- **Die Source 2X Common Base MRF549**
- Common Base Insertion Gain = 5.5 dB (Typ)
- High Collector-Base Breakdown Voltage $V_{(BR)CBO} = 100$ Vdc (Min)
- Emitter Ballasted For Improved Ruggedness
- Gold Top Metallization
- Silicon Nitride Passivation

MAXIMUM RATINGS (Note 1)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	70	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	600	mA dc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ Derate above 75°C	P_D	9 72	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	13.9	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted. Note 1.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 2$ mA dc, $I_E = 0$)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.2$ mA dc, $I_E = 0$)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.2$ mA dc, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 80$ Vdc, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	200	$\mu\text{A dc}$
Collector Cutoff Current ($V_{CB} = 80$ Vdc, $I_E = 0$)	I_{CBO}	—	—	40	$\mu\text{A dc}$

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mA dc, $V_{CE} = 10$ Vdc)	h_{FE}	15	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	5.1	—	pF
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	3.6	4.5	pF
Input Capacitance ($V_{EB} = 3$ Vdc, $f = 1$ MHz)	C_{ib}	—	20	—	pF

FUNCTIONAL TESTS

Common Base Gain ($V_{CB} = 10$ V, $I_C = 200$ mA, $f = 250$ MHz)	$ S_{21} ^2$	4.5	5.5	—	dB
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Note 1. Voltages and currents for PNP transistors are given for magnitude information only. Polarity is assumed to be opposite that of an NPN transistor.

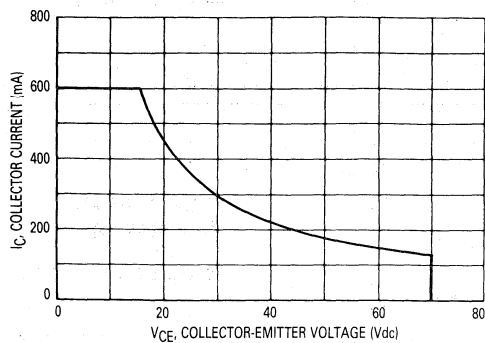


Figure 1. Safe Operating Area

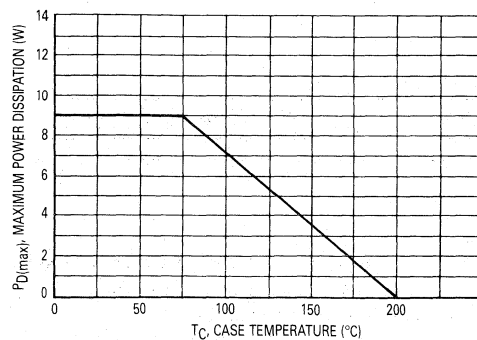


Figure 2. Power Dissipation versus Temperature

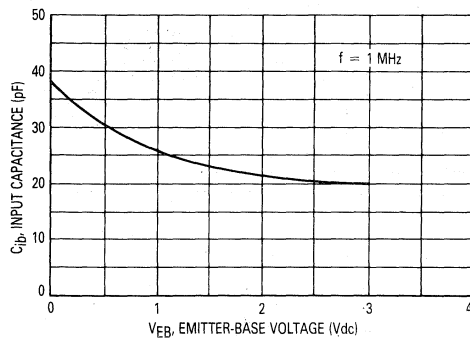


Figure 3. Input Capacitance versus Voltage

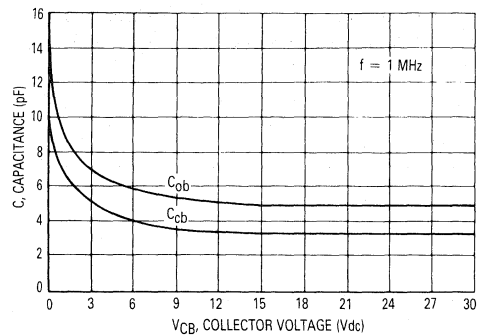


Figure 4. Junction Capacitance versus Voltage

MRF553

The RF Line

NPN SILICON RF LOW POWER TRANSISTOR

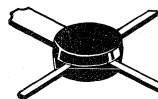
... designed primarily for wideband large signal predriver stages in the VHF frequency range.

- Specified @ 12.5 V, 175 MHz Characteristics
Output Power = 1.5 W
Minimum Gain = 11.5 dB
Efficiency 60% (Typ)
- Cost Effective PowerMacro Package
- Electroless Tin Plated Leads for Improved Solderability

1.5 W 175 MHz

**RF LOW POWER
TRANSISTOR**

NPN SILICON



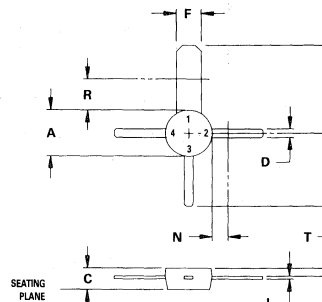
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	16	Vdc
Collector-Base Voltage	V _{CBO}	36	Vdc
Emitter-Base Voltage	V _{EBO}	4.0	Vdc
Collector-Current — Continuous	I _C	500	mA _{dc}
Total Device Dissipation @ T _C = 75°C (1,2)	P _D	3.0	Watts
Derate above 75°C		40	mW/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R _{θJC}	25	°C/W

- (1) T_C: Case temperature measured on collector lead immediately adjacent to body of package.
 (2) The MRF553 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques for PowerMacro Transistor," discusses methods of mounting and heatsinking.



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

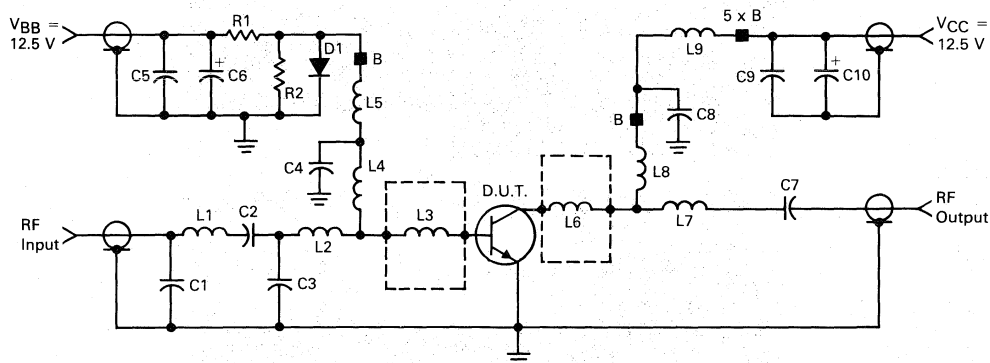
- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. LEAD DIMENSIONS UNCONTROLLED WITHIN DIMENSION N AND R.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.45	5.20	0.175	0.205
C	1.91	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	2.46	2.64	0.097	0.104
H	8.84	9.72	0.348	0.383
J	0.21	0.30	0.008	0.012
K	7.24	8.12	0.285	0.320
N	—	1.65	—	0.065
R	—	3.25	—	0.128
T	0.64	1.01	0.025	0.040

CASE 317D-02

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	30	—	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	12	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.5\text{ W}$, $f = 175\text{ MHz}$)	Figure 1,2 G_{pe}	11.5	13	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.5\text{ W}$, $f = 175\text{ MHz}$)	Figure 1,2 η	50	60	—	%
Load Mismatch Stress ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.5\text{ W}$, $f = 175\text{ MHz}$, $VSWR \geq 10:1$ All Phase Angles)	ψ	No Degradation in Output Power			—

FIGURE 1 — 140–175 MHz BROADBAND CIRCUIT SCHEMATIC

C1 — 36 pF Mini Underwood
 C2 — 47 pF Mini Underwood
 C3 — 91 pF Mini Underwood
 C4 — 68 pF Mini Underwood
 C5, C9 — 1.0 μF Erie Red Cap Capacitor
 C6, C10 — 0.1 μF , 35 V Tantalum
 C7 — 470 pF Chip Capacitor
 C8 — 2200 pF Chip Capacitor
 R1 — 4.7 k Ω , 1/4 W
 R2 — 100 Ω , 1/4 W
 D1 — 1N4148 Diode

L1 — 3 Turns, #18 AWG, 0.210" ID, 3/16" Length
 L2, L4, L7 — 0.62", #18 AWG Wire Bent into "V"
 L3, L6 — 60 x 125 x 250 Mils Copper Pad on 27 Mils Thick Alumina Substrate
 L5 — 12 μH Molded Choke
 L8 — 7 Turns, #18 AWG, 0.170" ID, 7/16" Length
 L9 — 1.0", #18 AWG Wire with 5 Ferrite Beads
 B — Ferrite Bead
 Board Material — Glass Teflon, $\epsilon_r = 2.56$, $t = 0.0625"$ (See Photomaster, Figure 3)

FIGURE 2 — 140-175 MHZ BROADBAND CIRCUIT

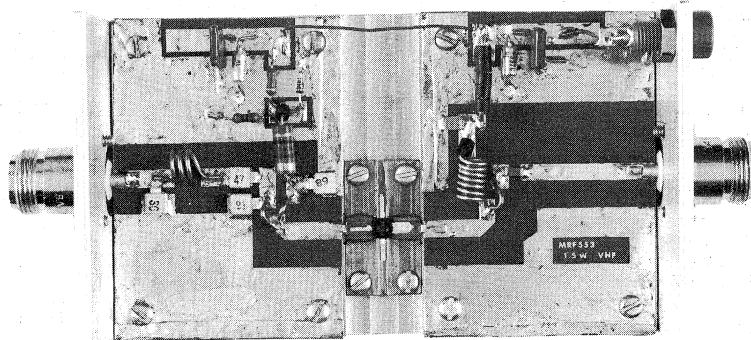
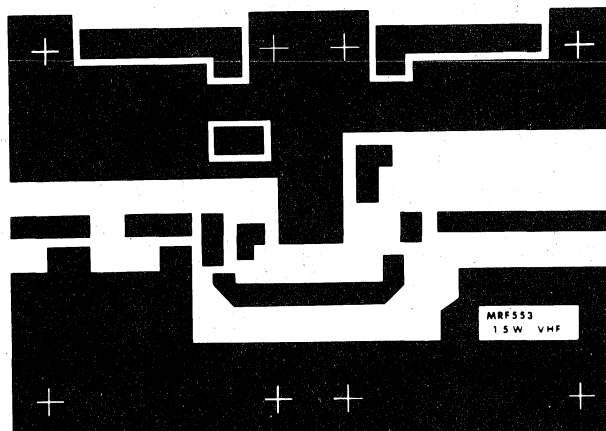
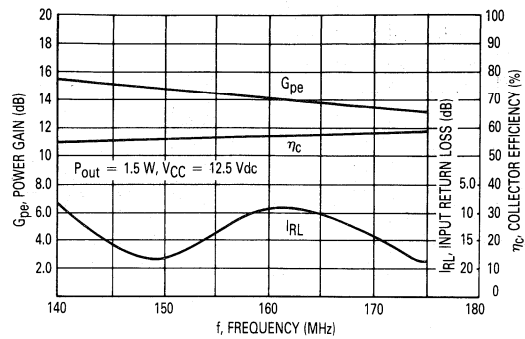


FIGURE 3 — 140-175 MHz TEST CIRCUIT PHOTOMASTER



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 4 — TYPICAL PERFORMANCE IN BROADBAND CIRCUIT

FIGURE 5 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

f Frequency MHz	Z_{in} Ohms						Z_{OL}^* Ohms					
	$V_{CC} = 7.5 \text{ V}; P_{in}$			$V_{CC} = 12.5 \text{ V}; P_{in}$			$V_{CC} = 7.5 \text{ V}; P_{out}$			$V_{CC} = 12.5 \text{ V}; P_{out}$		
	100 mW	200 mW	300 mW	50 mW	100 mW	150 mW	1.0 W	1.6 W	2.2 W	1.1 W	2.0 W	2.6 W
140	1.65-j3.6	2.0-j2.6	2.3-j1.2	1.7-j4.1	1.8-j3.1	1.9-j2.7	9.9-j11.1	10.6-j5.1	10-j4.9	28.3-j21.5	16-j20.5	16.3-j16.5
175	2.5-j5.6	2.3-j5.9	2.8-j4.0	2.3-j4.6	2.4-j1.2	2.4-j5.7	12.1-j14.9	7.2-j9.8	8.1-j5.4	30.8-j23.3	11.4-j20.9	11.1-j14.3

f Frequency MHz	Z_{in} Ohms						Z_{OL}^* Ohms					
	$V_{CC} = 7.5 \text{ V}; P_{in}$			$V_{CC} = 12.5 \text{ V}; P_{in}$			$V_{CC} = 7.5 \text{ V}; P_{out}$			$V_{CC} = 12.5 \text{ V}; P_{out}$		
	50 mW	100 mW	200 mW	25 mW	50 mW	100 mW	1.25 W	1.5 W	2.0 W	1.5 W	2.25 W	3.0 W
90	2.5-j9.3	2.5-j6.4	2.5-j4.4	1.6-j10.7	2.5-j7.1	2.2-j1.3	31.8-j9.2	32-j8.9	30.2-j10.7	45.8-j7.2	45.2-j3.9	40-j4.5

* Z_{OL} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage and frequency.

FIGURE 6 — POWER OUTPUT versus POWER INPUT

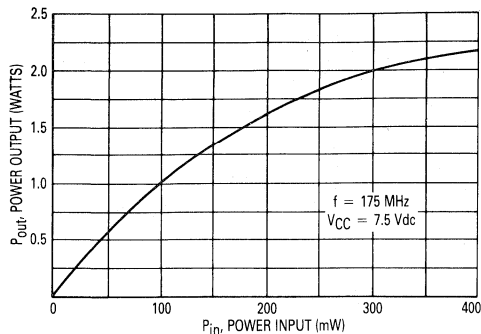


FIGURE 7 — POWER OUTPUT versus POWER INPUT

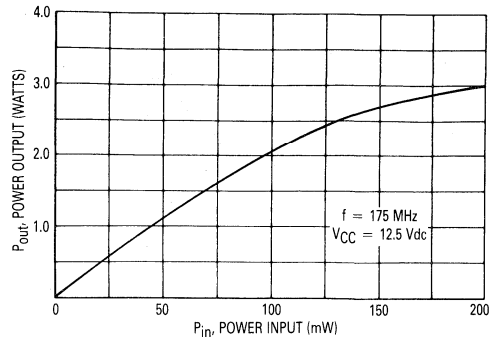


FIGURE 8 — POWER OUTPUT versus FREQUENCY

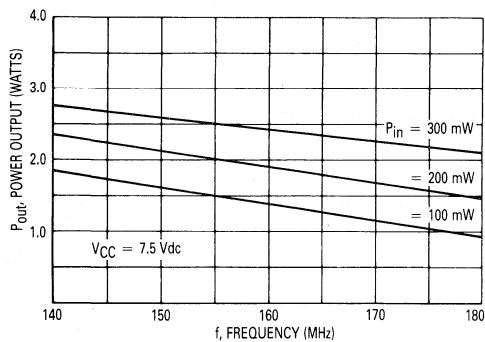


FIGURE 9 — POWER OUTPUT versus FREQUENCY

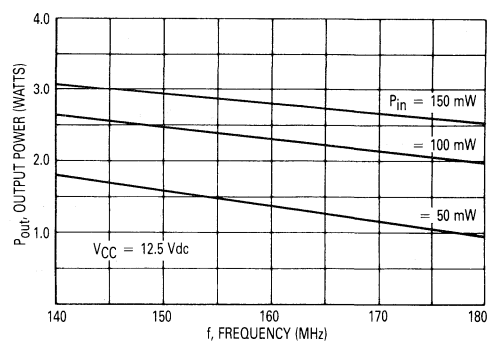


FIGURE 10 — POWER OUTPUT versus COLLECTOR VOLTAGE

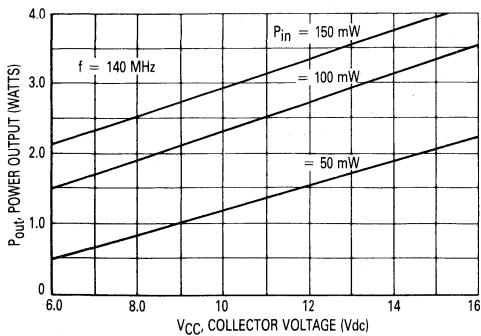
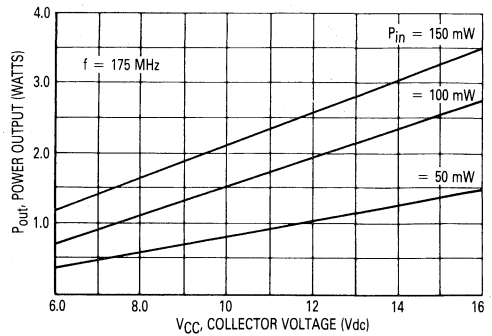


FIGURE 11 — POWER OUTPUT versus COLLECTOR VOLTAGE



The RF Line

NPN Silicon

RF Low Power Transistor

... designed primarily for wideband large signal predriver stages in the UHF frequency range.

- Specified @ 12.5 V, 470 MHz Characteristics @ $P_{out} = 1.5$ W
Common Emitter Power Gain = 12.5 dB (Typ)
Efficiency 60% (Typ)
- Cost Effective PowerMacro Package
- Electroless Tin Plated Leads for Improved Solderability

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	400	mA _{dc}
Operating Junction Temperature	T_J	150	°C
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ (1,2) Derate above 75°C	P_D	3 40	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5$ mA _{dc} , $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5$ mA _{dc} , $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA _{dc} , $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	0.1	mA _{dc}

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mA _{dc} , $V_{CE} = 5$ Vdc)	h_{FE}	50	90	200	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15$ Vdc, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	3.5	5	pF
--	----------	---	-----	---	----

FUNCTIONAL TESTS ($f = 470$ MHz)

Common-Emitter Power Gain ($V_{CC} = 12.5$ Vdc, $P_{out} = 1.5$ W)	G_{pe}	11	12.5	—	dB
Collector Efficiency ($V_{CC} = 12.5$ Vdc, $P_{out} = 1.5$ W)	η_c	50	60	—	%
Load Mismatch Stress ($V_{CC} = 15.5$ Vdc, $P_{in} = 125$ mW, $VSWR \geq 10:1$ all phase angles)	ψ	No Degradation in Output Power			

(1) T_C , Case temperature, measured on collector lead immediately adjacent to body of package.

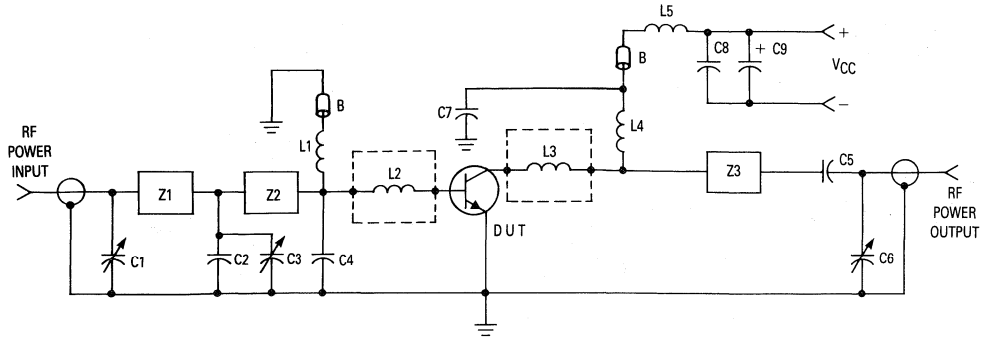
(2) The MRF555 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques in PowerMacro Transistor," discusses methods of mounting and heatsinking.

MRF555

1.5 W 470 MHz
RF LOW POWER
TRANSISTOR
NPN SILICON



CASE 317D-02, STYLE 2



- *C1, C3, C6 — 0.8–11 pF Johanson
- C2 — 15 pF Clamped Mica, Mini-Underwood
- C4 — 36 pF Clamped Mica, Mini-Underwood
- C5 — 470 pF Ceramic Chip Capacitor
- C7 — 91 pF Clamped Mica, Mini-Underwood
- C8 — 68 pF Clamped Mica, Mini-Underwood
- C9 — 1 μ F, 25 V Tantalum
- B — Bead, Ferroxcube 56-590-65/3B
- L1 — 5 Turns #21 AWG, 5/32" I.D.
- L2, L3 — 60 x 125 x 250 Mils Copper Pad on 27 Mil Thick Alumina Substrate
- L4, L5 — 7 Turns #21 AWG 5/32" I.D.
- Z1 — 1.29" x 0.16" Microstrip
- Z2 — 0.70" x 0.16" Microstrip
- Z3 — 2.18" x 0.16" Microstrip
- PCB — 1/16" Glass Teflon, 1 oz. cu. clad, double sided, $\epsilon_r = 2.5$
- (See Figure 5 — Photomaster)

*Fixed tuned for broadband response.

Figure 1. 400–512 MHz Broadband Circuit

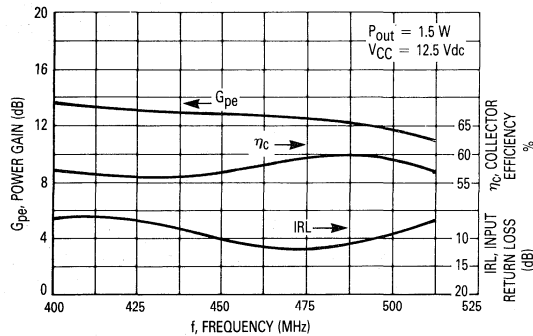


Figure 2. Performance in Broadband Circuit

f Frequency MHz	Z _{in} Ohms		Z _{OL} * Ohms	
	V _{CC} = 7.5 V	V _{CC} = 12.5 V	V _{CC} = 7.5 V	V _{CC} = 12.5 V
	P _{in} = 100 mW	P _{in} = 50 mW	P _{out} 400 MHz = 1.5 W P _{out} 450 MHz = 1.35 W P _{out} 512 MHz = 1.05 W	P _{out} 400 MHz = 1.9 W P _{out} 450 MHz = 1.45 W P _{out} 512 MHz = 0.9 W
400	2.9 – j2.7	1.9 – j3.1	18.0 – j13.4	12.2 – j19.7
450	2.2 – j0.8	2.6 – j4.0	21.6 – j9.9	20.2 – j18.6
512	3.5 – j1.2	2.6 – j2.6	20.1 – j1.0	23.4 – j23.0

*Z_{OL} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 3. Z_{in} and Z_{OL} versus Collector Voltage, Input Power and Output Power

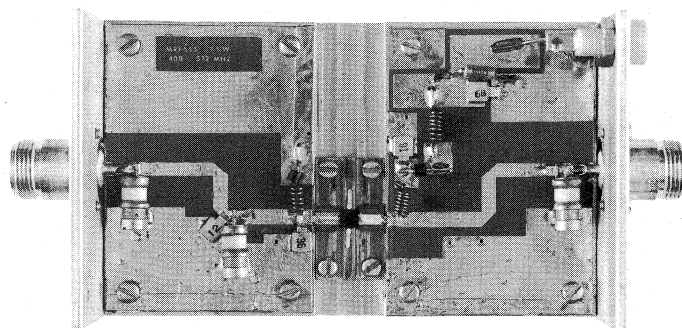
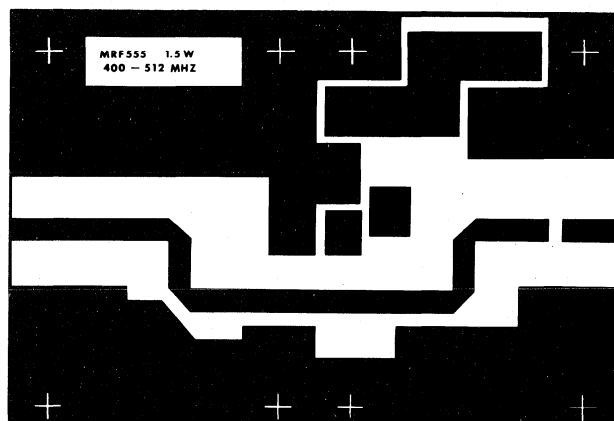


Figure 4. 400-512 MHz Broadband Circuit

2



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 5. 400-512 MHz Broadband Circuit Photomaster

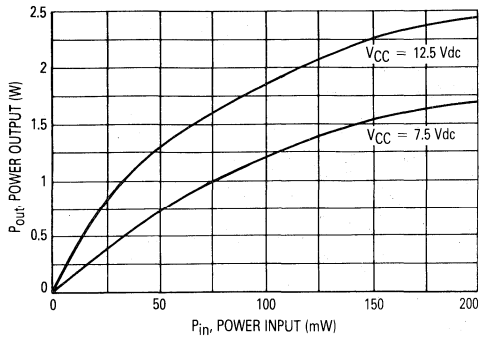


Figure 6. Power Output versus Power Input

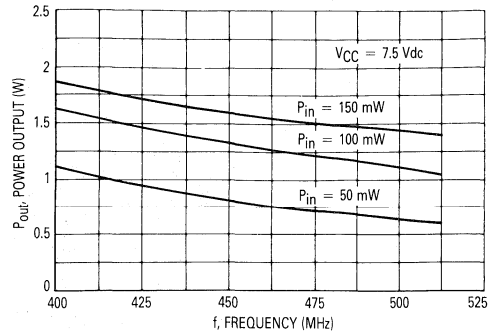


Figure 7. Power Output versus Frequency

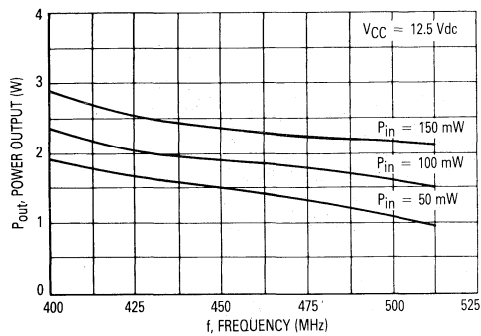


Figure 8. Power Output versus Frequency

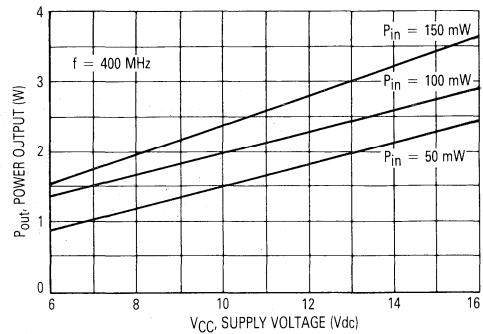


Figure 9. Power Output versus Supply Voltage

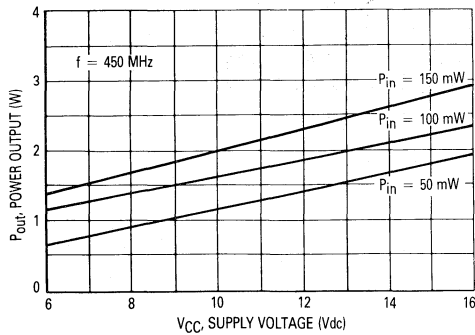


Figure 10. Power Output versus Supply Voltage

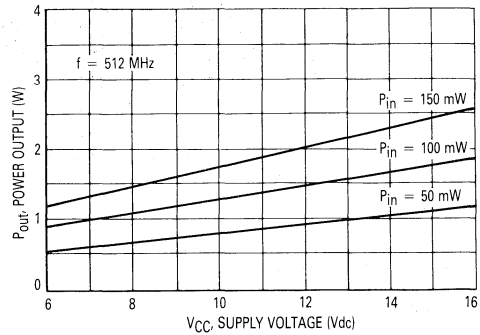


Figure 11. Power Output versus Supply Voltage

MRF557

The RF Line

NPN SILICON RF LOW POWER TRANSISTOR

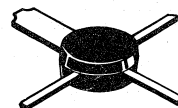
... designed primarily for wideband large signal predriver stages in the 800 MHz frequency range.

- Specified @ 12.5 V, 870 MHz Characteristics
Output Power = 1.5 W
Minimum Gain = 8.0 dB
Efficiency 60% (Typ)
- Cost Effective PowerMacro Package
- Electroless Tin Plated Leads for Improved Solderability

1.5 W 870 MHz

**RF LOW POWER
TRANSISTOR**

NPN SILICON



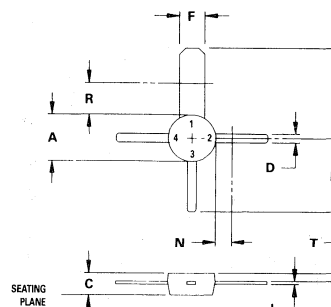
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	16	Vdc
Collector-Base Voltage	V _{CBO}	36	Vdc
Emitter-Base Voltage	V _{EBO}	4.0	Vdc
Collector-Current — Continuous	I _C	400	mA _{dc}
Total Device Dissipation @ T _C = 75°C (1,2) Derate above 75°C	P _D	3.0 40	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R _{θJC}	25	°C/W

- (1) T_C, Case temperature measured on collector lead immediately adjacent to body of package.
(2) The MRF557 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques in PowerMacro Transistor," discusses methods of mounting and heatsinking.



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. LEAD DIMENSIONS UNCONTROLLED WITHIN DIMENSION N AND R.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.45	5.20	0.175	0.205
B	1.91	2.54	0.075	0.100
C	0.84	0.99	0.033	0.039
D	2.46	2.64	0.097	0.104
E	8.84	9.72	0.348	0.383
F	0.21	0.30	0.008	0.012
G	7.24	8.12	0.285	0.320
H	—	1.65	—	0.065
I	—	3.25	—	0.128
J	0.64	1.01	0.025	0.040

CASE 317D-02

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	0.1	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100 \text{ mA}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	50	90	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	3.5	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 1.5 \text{ W}$, $f = 870 \text{ MHz}$)	Figures 1, 2 G_{pe}	8.0	9.0	—	dB
Collector Efficiency ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 1.5 \text{ W}$, $f = 870 \text{ MHz}$)	Figures 1, 2 η_C	55	60	—	%
Load Mismatch Stress ($V_{CC} = 15.5 \text{ Vdc}$, $P_{in} = 225 \text{ mW}$, $f = 870 \text{ MHz}$, $V_{SWR} \geq 10:1$ all phase angles)	Figures 1, 2 ψ	No Degradation in Output Power			

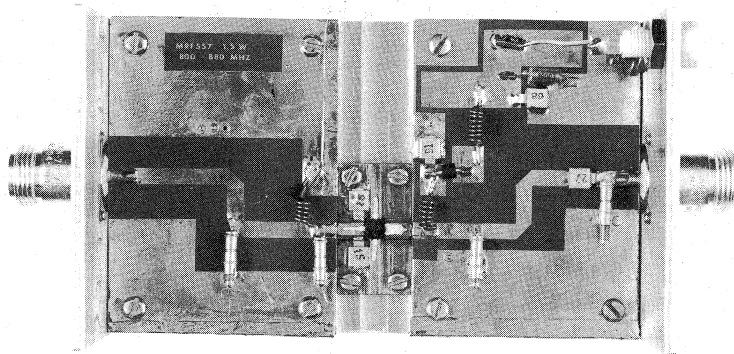
C1, C2, C5, C7 — 0.8–8.0 pF, Johnson Gigatrim®
L1, L4 — 5 Turns #21 AWG 5/32" ID

- C1, C2, C5, C7 — 0.8–8.0 pF Johanson Gigatrim*
C3, C4 — 15 pF Clamped Mica, Mini-Underwood
C6 — 27 pF Clamped Mica, Mini-Underwood
C8 — 91 pF Clamped Mica, Mini-Underwood
C9 — 68 pF Clamped Mica, Mini-Underwood
C10 — 1.0 μ F, 25 V Tantalum
B — Bead, Ferroxcube 56-590-65/3B
PCB — 1/16" Glass Teflon, $\epsilon_r = 2.56$
(See Photomaster Figure 3)

- L1, L4 — 5 Turns #21 AWG, 5/32" ID
L2, L3 — 60 x 125 x 250 Mils Copper Tab on
27 Mil Thick Alumina Substrate
L5 — 7 Turns #21 AWG, 5/32" ID
Z1 — 1.65 x 0.163" Microstrip, $Z_0 = 50 \Omega$
Z2 — 0.85 x 0.163" Microstrip, $Z_0 = 50 \Omega$
Z3 — 0.625 x 0.163" Microstrip, $Z_0 = 50 \Omega$
Z4 — 1.35 x 0.163" Microstrip, $Z_0 = 50 \Omega$

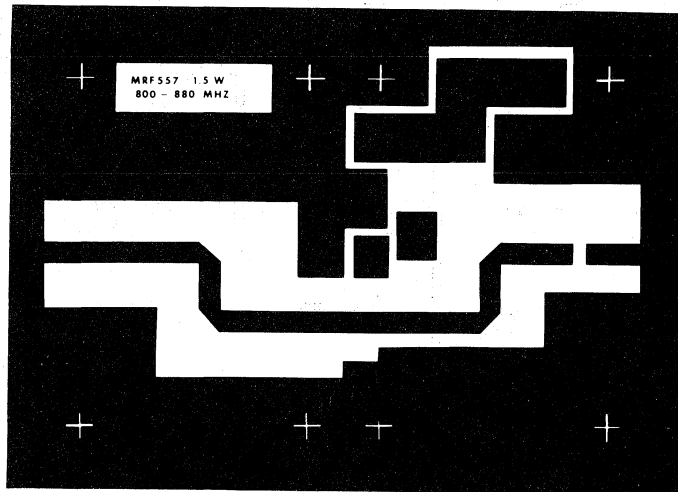
MOTOROLA RF DEVICE DATA

FIGURE 2 — 800-880 MHz BROADBAND CIRCUIT



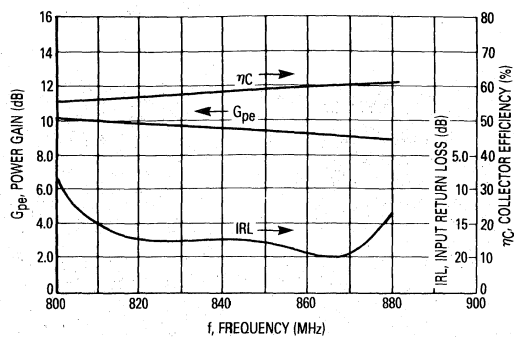
2

FIGURE 3 — 800-880 MHz TEST CIRCUIT PHOTOMASTER



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 4 — PERFORMANCE IN BROADBAND CIRCUIT

FIGURE 5 — Z_{in} and Z_{ol} versus COLLECTOR VOLTAGE, INPUT POWER AND OUTPUT POWER

f FREQUENCY MHz	Z_{in} Ohms		Z_{OL}^* Ohms	
	$V_{CC} = 7.5 \text{ V}$	$V_{CC} = 12.5 \text{ V}$	$V_{CC} = 7.5 \text{ V}$	$V_{CC} = 12.5 \text{ V}$
	$P_{in} = 300 \text{ mW}$	$P_{in} = 200 \text{ mW}$	$P_{out} \text{ 806 MHz} = 1.7 \text{ W}$ $P_{out} \text{ 870 MHz} = 1.4 \text{ W}$ $P_{out} \text{ 960 MHz} = 1.0 \text{ W}$	$P_{out} \text{ 806 MHz} = 2.1 \text{ W}$ $P_{out} \text{ 870 MHz} = 1.8 \text{ W}$ $P_{out} \text{ 960 MHz} = 1.1 \text{ W}$
806	$2.4 + j3.9$	$2.4 + j3.1$	$14.7 - j4.4$	$13.6 - j12.8$
870	$2.5 + j4.6$	$2.7 + j3.7$	$17.2 - j8.6$	$16 - j13.2$
960	$6.1 + j7.4$	$6.8 + j8.3$	$40 - j8.3$	$38 - j10.5$

* Z_{OL} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage and frequency.

FIGURE 6 — POWER OUTPUT versus POWER INPUT

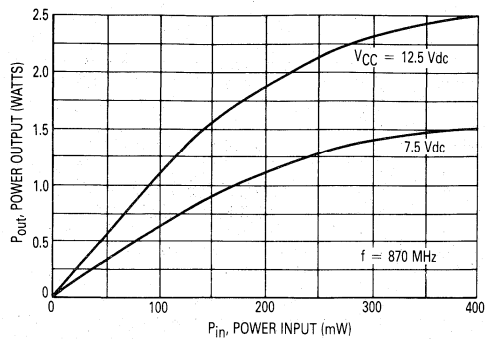


FIGURE 7 — POWER OUTPUT versus FREQUENCY

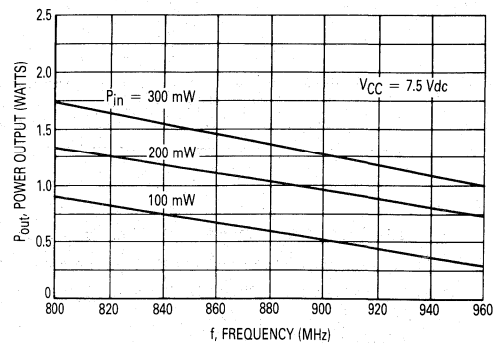


FIGURE 8 — POWER OUTPUT versus FREQUENCY

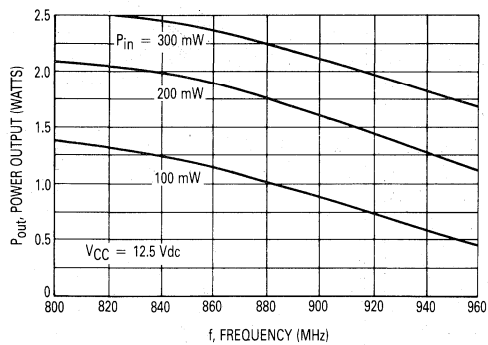


FIGURE 9 — POWER OUTPUT versus SUPPLY VOLTAGE

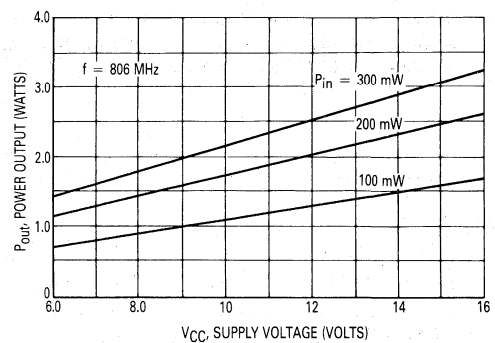


FIGURE 10 — POWER OUTPUT versus SUPPLY VOLTAGE

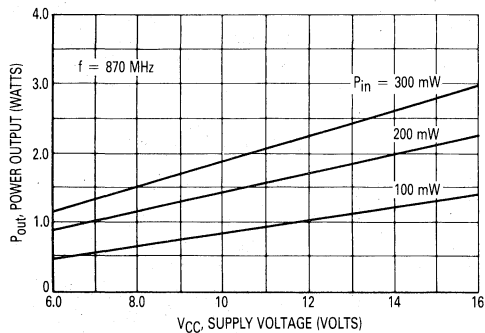
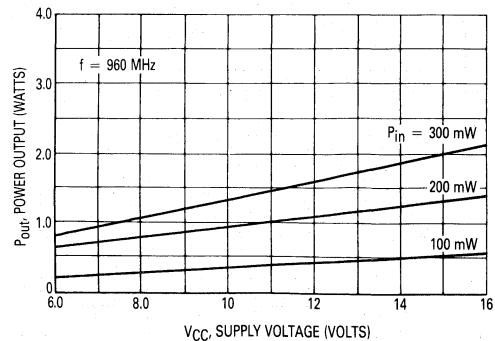


FIGURE 11 — POWER OUTPUT versus SUPPLY VOLTAGE



MRF559

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed for UHF linear and large-signal amplifier applications.

- Specified 12.5 Volt, 870 MHz Characteristics —
Output Power = 0.5 Watts
Minimum Gain = 8.0 dB
Efficiency = 50%
- S Parameter Data From 250 MHz to 1.5 GHz
- 1.0 dB Compression > +20 dBm Typ
- Ideally Suited for Broadband, Class A, Low-Noise Applications
- Recommended As Driver for MHW808 and MHW820,
806-870 MHz Power Modules

0.5 W — 870 MHz

**HIGH FREQUENCY
TRANSISTOR**

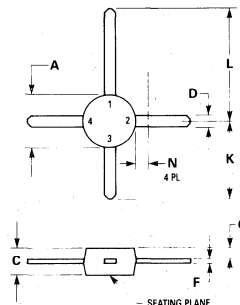
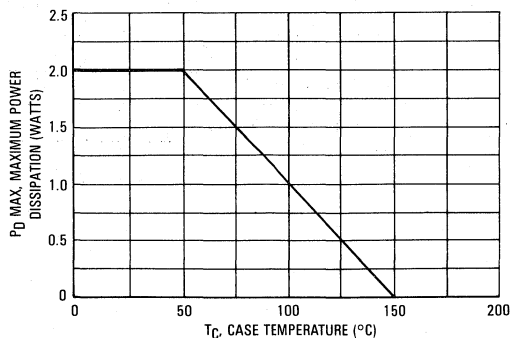
NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEQ}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector-Current — Continuous	I_C	150	mA dc
Total Device Dissipation @ $T_C = 50^\circ\text{C}$ Derate above 50°C	P_D	2.0 20	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

POWER DISSIPATION



STYLE 2:

- PIN 1: COLLECTOR
- 2: EMITTER
- 3: BASE
- 4: EMITTER

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit	
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc	
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc	
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{A}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc	
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	1.0	mAdc	
ON CHARACTERISTICS						
DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	30	90	200	—	
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	—	3000	—	MHz	
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	2.0	2.5	pF	
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.5\text{ W}$)	$f = 870\text{ MHz}$ $f = 512\text{ MHz}$	G_{PE}	8.0 —	9.5 13	— —	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.5\text{ W}$)	$f = 870\text{ MHz}$ $f = 512\text{ MHz}$	η	50 —	65 60	— —	%
TYPICAL PERFORMANCE @ $V_{CC} = 7.5\text{ V}$						
Common-Emitter Amplifier Power Gain ($V_{CC} = 7.5\text{ Vdc}$, $P_{out} = 0.5\text{ W}$)	$f = 870\text{ MHz}$ $f = 512\text{ MHz}$	G_{PE}	— —	6.5 10	— —	dB
Collector Efficiency ($V_{CC} = 7.5\text{ Vdc}$, $P_{out} = 0.5\text{ W}$)	$f = 870\text{ MHz}$ $f = 512\text{ MHz}$	η	— —	70 65	— —	%

FIGURE 1 — 870 MHz TEST FIXTURE

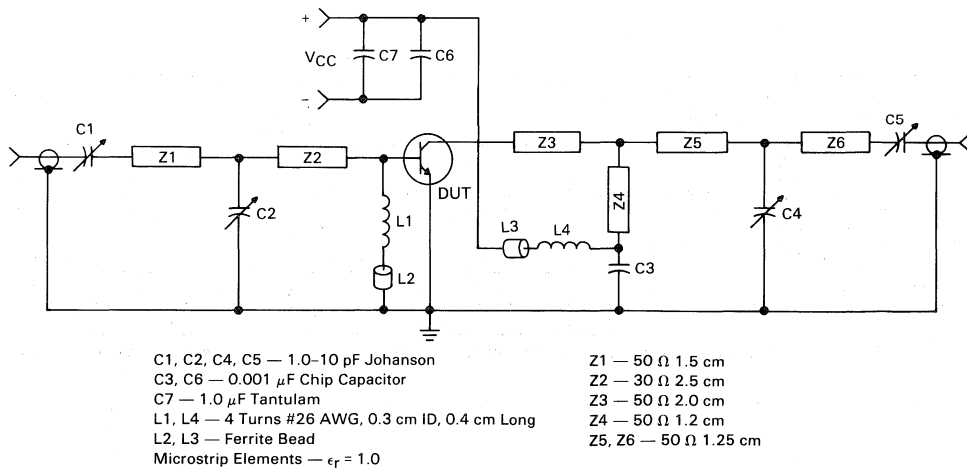


FIGURE 2 — OUTPUT POWER versus INPUT POWER
f = 512 MHz

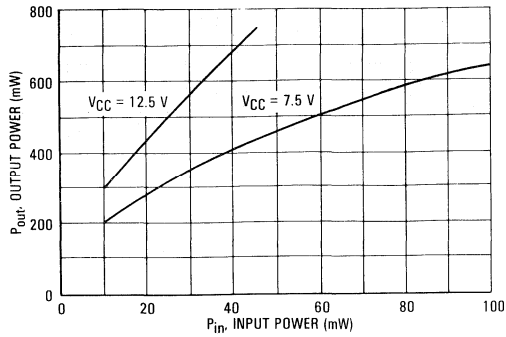


FIGURE 3 — OUTPUT POWER versus FREQUENCY
V_{CC} = 7.5 V

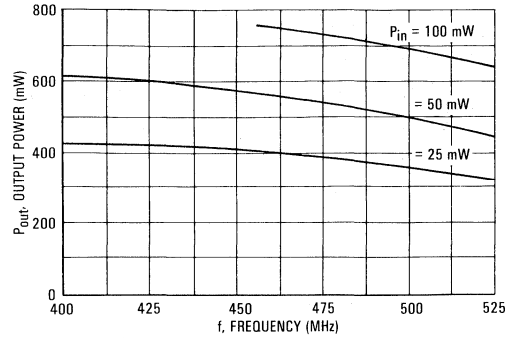


FIGURE 4 — OUTPUT POWER versus COLLECTOR VOLTAGE
f = 512 MHz

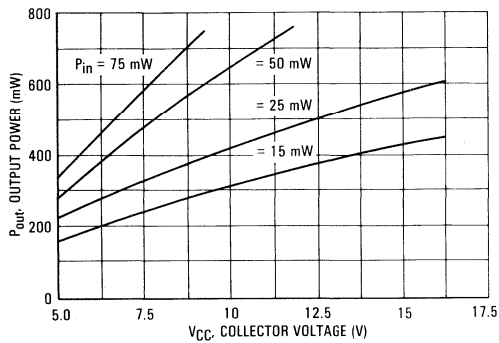


FIGURE 5 — OUTPUT POWER versus FREQUENCY
V_{CC} = 12.5 V

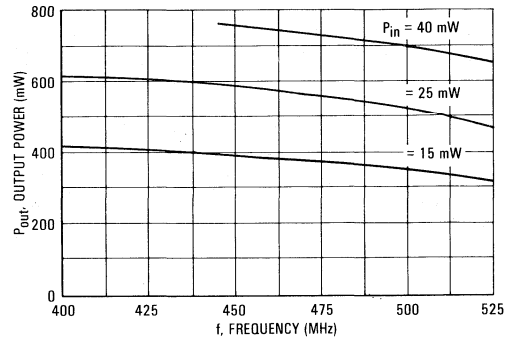


FIGURE 6 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

f FREQUENCY MHz	Z_{in} OHMS			Z_{OL}^* OHMS					
	V _{CC} = 7.5-12.5 V			V _{CC} = 7.5 V			V _{CC} = 12.5 V		
	15 mW	25 mW	50 mW	0.25 W	0.50 W	0.75 W	0.25 W	0.50 W	0.75 W
400	4.3 - j13.3	4.9 - j11.0	5.7 - j8.7	31 - j49	44 - j34	42 - j4.9	20 - j68	42 - j60	52 - j54
440	3.9 - j8.8	4.5 - j8.7	5.4 - j6.9	27 - j42	39 - j30	40 - j6.9	19 - j62	37 - j54	49 - j50
480	3.5 - j4.4	4.1 - j6.5	5.0 - j4.3	24 - j36	36 - j25	39 - j9.0	18 - j56	33 - j48	47 - j46
520	3.2 - j2.2	3.8 - j4.3	4.7 - j1.7	22 - j30	34 - j20	37 - j12	17 - j52	31 - j44	47 - j42

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — OUTPUT POWER versus INPUT POWER
f = 870 MHz

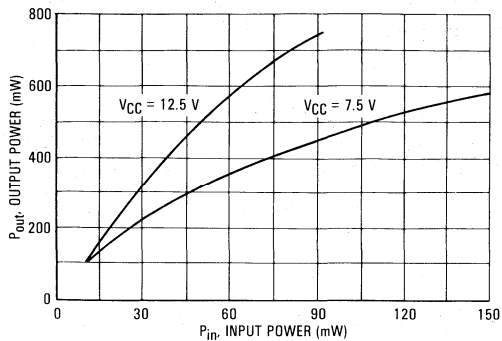


FIGURE 8 — OUTPUT POWER versus FREQUENCY
V_{CC} = 7.5 V

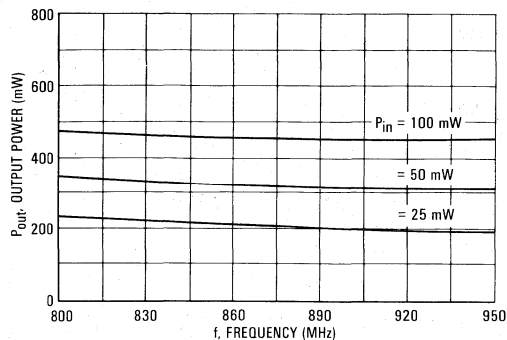


FIGURE 9 — OUTPUT POWER versus COLLECTOR VOLTAGE
f = 870 MHz

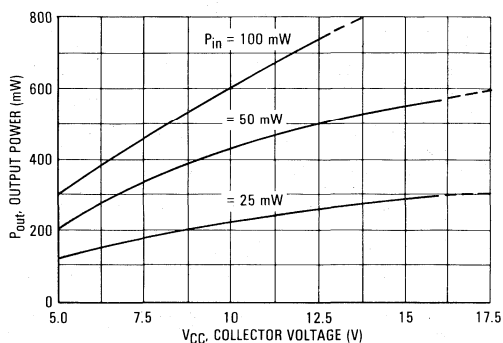


FIGURE 10 — OUTPUT POWER versus FREQUENCY
V_{CC} = 12.5 V

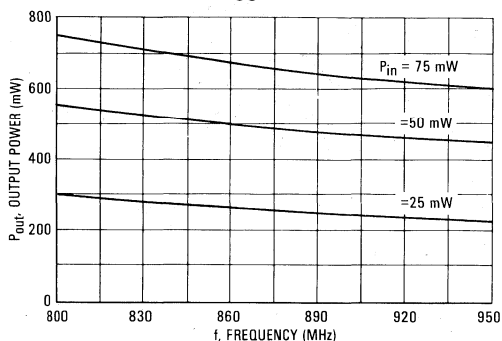
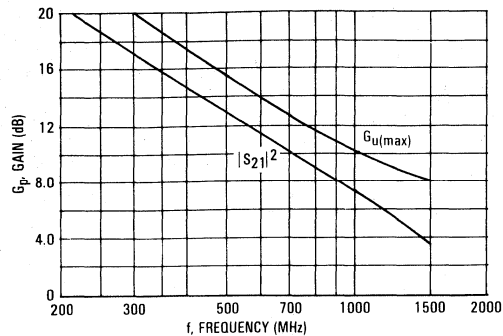


FIGURE 11 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

f FREQUENCY MHz	Z _{in} OHMS			Z _{OL} * OHMS					
	V _{CC} = 7.5-12.5 V			V _{CC} = 7.5 V			V _{CC} = 12.5 V		
	25 mW	50 mW	100 mW	0.25 W	0.50 W	0.75 W	0.25 W	0.50 W	0.75 W
800	2.9 + j2.2	3.8 + j4.4	4.7 + j6.5	15.0 - j36.8	22.7 - j30.6	27.1 - j22.6	14.6 - j43.6	17.2 - j39.7	23.4 - j37.7
850	3.2 + j3.5	3.8 + j5.2	4.8 + j7.4	15.7 - j35.3	23.9 - j28.7	27.3 - j21.5	16.3 - j40.8	17.8 - j39.5	23.7 - j36.8
900	3.8 + j5.7	4.4 + j7.0	5.4 + j8.7	16.4 - j33.7	25.1 - j27.0	27.5 - j20.5	17.3 - j38.2	18.3 - j39.3	23.9 - j36.0
950	4.1 + j7.4	4.5 + j8.8	5.5 + j10.1	17.0 - j32.2	26.3 - j25.2	27.6 - j19.4	17.2 - j36.1	20.1 - j38.5	24.5 - j35.6

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 12 — GAIN versus FREQUENCY
 $V_{CE} = 10 \text{ V}$, $I_C = 50\text{-}100 \text{ mA}$



$$G_{u(max)} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

FIGURE 13 — GAIN versus COLLECTOR CURRENT
 $V_{CE} = 10 \text{ V}$

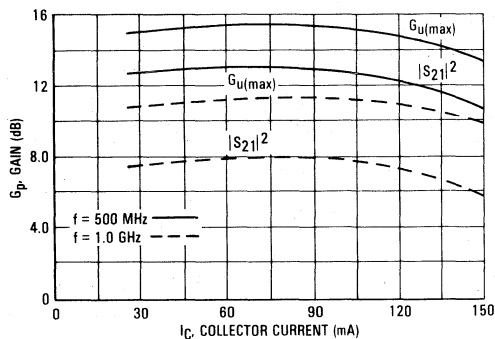


FIGURE 14 — NOISE FIGURE AND ASSOCIATED GAIN
 versus COLLECTOR CURRENT
 $V_{CE} = 10 \text{ V}$

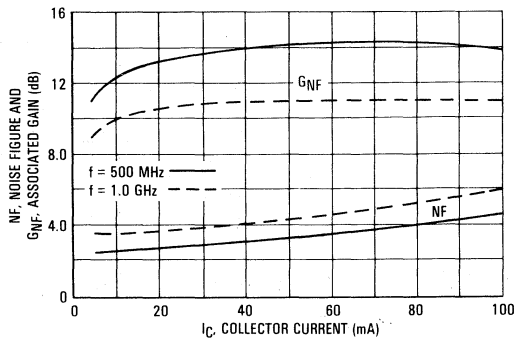


FIGURE 15 — CURRENT GAIN BANDWIDTH PRODUCT
 versus COLLECTOR CURRENT
 $V_{CE} = 10 \text{ V}$

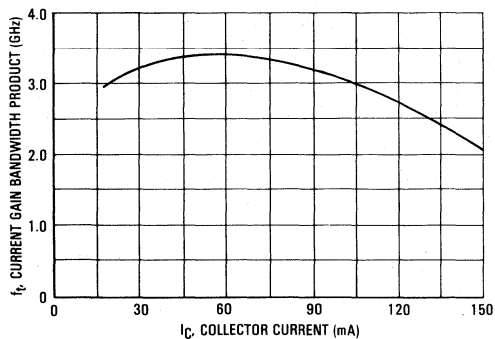


FIGURE 16 — OUTPUT CAPACITANCE versus
 COLLECTOR BASE VOLTAGE

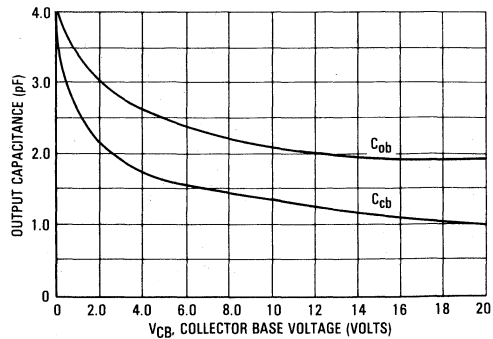


FIGURE 17 — COMMON EMITTER SCATTERING PARAMETERS

V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
5.0	10	250	0.72	-161	6.20	93	0.057	30	0.30	-91
		500	0.73	179	3.16	76	0.069	43	0.27	-94
		1000	0.76	158	1.62	55	0.105	63	0.27	-119
		1500	0.82	142	1.08	41	0.155	70	0.41	-137
	25	250	0.70	-173	7.17	89	0.045	47	0.26	-123
		500	0.70	172	3.63	75	0.073	60	0.20	-128
		1000	0.74	152	1.90	54	0.134	67	0.21	-157
		1500	0.79	136	1.32	39	0.196	66	0.32	-167
	50	250	0.72	-178	7.63	89	0.038	56	0.27	-139
		500	0.72	170	3.85	77	0.068	67	0.23	-141
		1000	0.75	153	2.01	59	0.129	72	0.23	-162
		1500	0.81	137	1.40	46	0.188	70	0.32	-164
	100	250	0.73	179	7.34	88	0.036	61	0.26	-143
		500	0.74	169	3.70	77	0.067	71	0.22	-144
		1000	0.76	153	1.94	59	0.130	74	0.24	-166
		1500	0.81	138	1.36	46	0.191	71	0.32	-167
	150	250	0.78	176	5.19	92	0.033	64	0.22	-131
		500	0.78	167	2.76	78	0.065	74	0.21	-131
		1000	0.80	151	1.49	58	0.129	77	0.24	-155
		1500	0.85	135	1.05	45	0.191	73	0.35	-161
10	10	250	0.69	-157	7.03	94	0.050	33	0.34	-67
		500	0.70	-178	3.59	77	0.060	46	0.32	-69
		1000	0.74	160	1.84	55	0.094	67	0.29	-94
		1500	0.81	142	1.20	41	0.148	76	0.42	-121
	25	250	0.67	-168	8.30	91	0.039	46	0.24	-93
		500	0.68	176	4.25	77	0.060	60	0.21	-89
		1000	0.72	158	2.19	57	0.109	71	0.19	-114
		1500	0.78	142	1.47	44	0.165	74	0.31	-134
	50	250	0.68	-174	8.88	90	0.035	55	0.21	-110
		500	0.68	172	4.49	77	0.060	67	0.18	-104
		1000	0.72	155	2.31	59	0.113	74	0.17	-128
		1500	0.77	139	1.58	46	0.169	74	0.28	-140
	100	250	0.68	-178	8.49	89	0.03	61	0.19	-104
		500	0.69	170	4.32	76	0.06	71	0.17	-97
		1000	0.72	153	2.25	58	0.12	76	0.17	-123
		1500	0.78	137	1.53	44	0.18	75	0.28	-137
	150	250	0.72	178	6.53	91	0.029	64	0.22	-71
		500	0.73	169	3.37	77	0.056	75	0.24	-75
		1000	0.76	152	1.79	57	0.112	80	0.22	-105
		1500	0.83	137	1.22	43	0.175	79	0.34	-129

FIGURE 18 — TUNABLE TEST FIXTURE

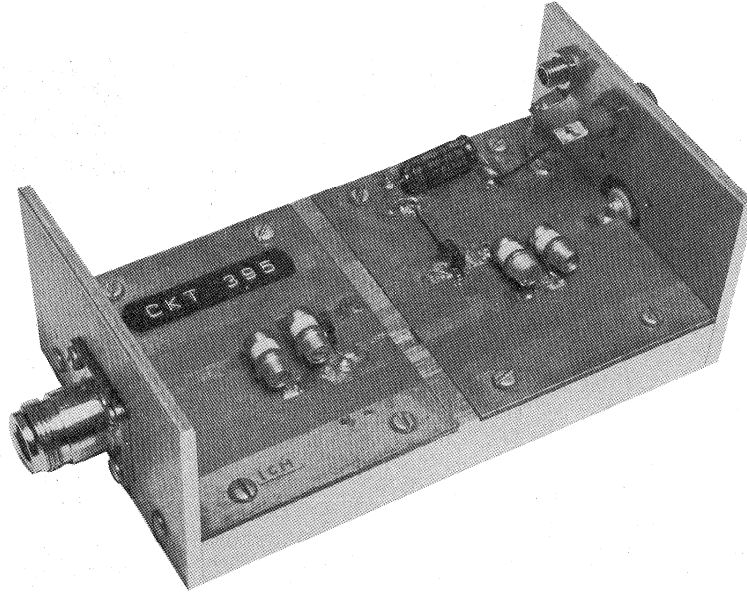
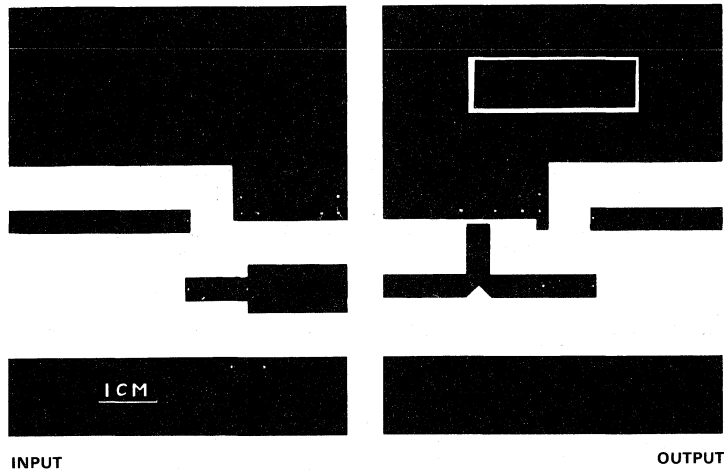


FIGURE 19 — PRINTED CIRCUIT BOARD LAYOUT



NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS

... designed for low-noise, wide dynamic range front end amplifiers, low-noise VCO's, and microwave power multipliers.


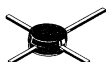
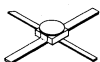
- Low Noise
- High Gain
- Available in Low Cost Plastic, High Reliability Ceramic or Die
- State-of-the-Art Technology
 - Fine Line Geometry
 - Ion Implanted Arsenic Emitters
 - Gold Top Metallization and Wires
 - Silicon Nitride Passivation
- Fully Characterized

MRF571
MRF572
MRFC572

$f_T = 8.0 \text{ GHz @ } 50 \text{ mA}$
 $NF = 1.0 \text{ dB @ } 500 \text{ MHz}$
 $NF = 1.5 \text{ dB @ } 1.0 \text{ GHz}$
 $NF = 2.5 \text{ dB @ } 2.0 \text{ GHz}$

HIGH FREQUENCY
TRANSISTORS

NPN SILICON

		MRFC572	MRF571	MRF572	
					
		Chip	Macro-X Case 317-01 Style 2	Case 303-01 Style 1	
Ratings	Symbol	Values			Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	3.0	3.0	Vdc
Collector Current — Continuous	I_C	70	70	70	mAdc
Total Device Dissipation @ $T_C = 50^\circ\text{C}$ ⁽¹⁾ Derate above $T_C = 50^\circ\text{C}$	P_D	0.75 $T_J = 200^\circ\text{C}$ max	1.0 10	0.75 5.0	Watts mW/°C
Storage Temperature	T_{stg}	-65 to +200	-65 to +150	-65 to +200	°C

NOTE 1. Case temperature measured on collector lead immediately adjacent to body of package.

MRF571, MRF572, MRFC572

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 50\text{ }\mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 8.0\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 30\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 6.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{cb}	—	0.7	1.0	pF
Current Gain — Bandwidth Product ($V_{CE} = 8.0\text{ Vdc}$, $I_C = 50\text{ mA}$, $f = 1.0\text{ GHz}$)	f_T	—	8.0	—	GHz
FUNCTIONAL TESTS					
Gain @ Noise Figure ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$) <div>$f = 0.5\text{ GHz}$ $f = 1.0\text{ GHz}$</div>	GNF	<div>— 10</div>	<div>16.5 12</div>	<div>— —</div>	dB
Noise Figure ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$) <div>$f = 0.5\text{ GHz}$ $f = 1.0\text{ GHz}$ MRF571 $f = 2.0\text{ GHz}$ MRF572 $f = 2.0\text{ GHz}$</div>	NF	<div>— — — —</div>	<div>1.0 1.5 2.8 2.5</div>	<div>— 2.0 — —</div>	dB

FIGURE 1 — C_{cb} , COLLECTOR-BASE CAPACITANCE
versus VOLTAGE

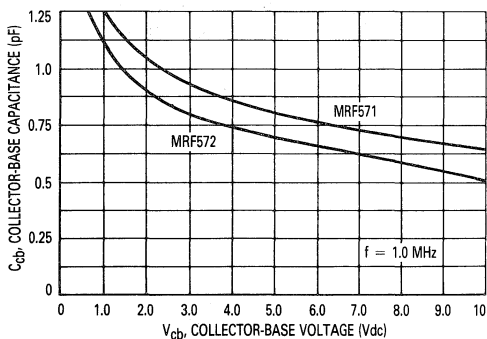


FIGURE 2 — C_{ib} , INPUT CAPACITANCE
versus EMITTER BASE VOLTAGE

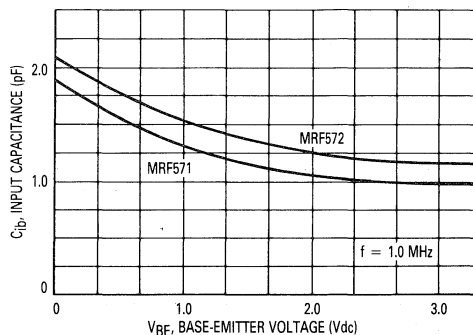


FIGURE 3 — MRF571 — GAIN AT NOISE FIGURE AND
NOISE FIGURE versus FREQUENCY

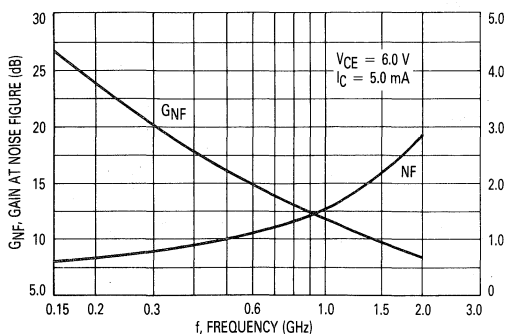


FIGURE 4 — MRF572 — GAIN AT NOISE FIGURE
AND NOISE FIGURE versus FREQUENCY

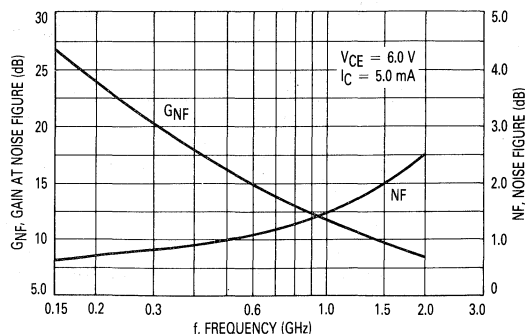


FIGURE 5 — MRF571 and MRF572 — GAIN AT NOISE
FIGURE AND NOISE FIGURE versus COLLECTOR CURRENT

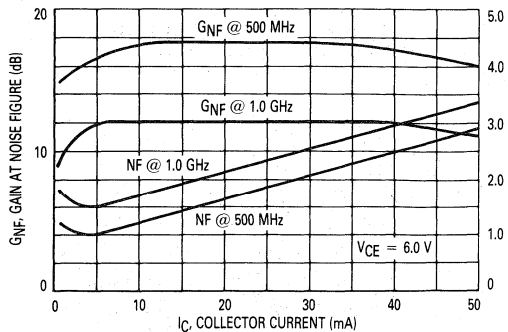


FIGURE 6 — f_T , CURRENT GAIN-BANDWIDTH PRODUCT
versus COLLECTOR CURRENT

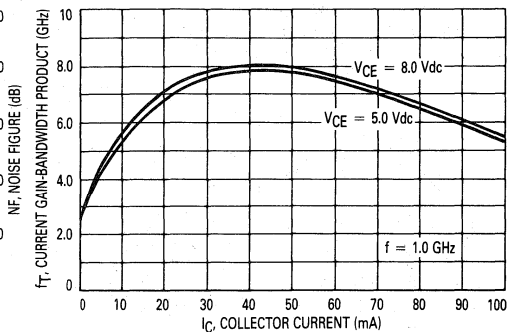


FIGURE 7 — G_{Amax} , MAXIMUM AVAILABLE GAIN
versus FREQUENCY

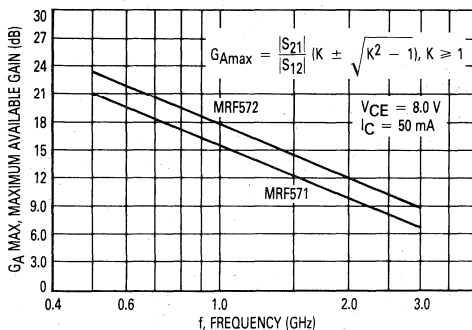


FIGURE 8 — 1.0 dB COMPRESSION PT.
AND THIRD ORDER INTERCEPT

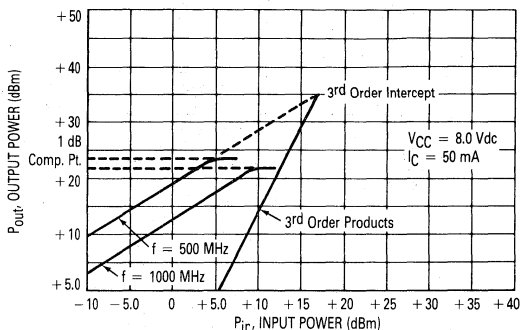


FIGURE 9 — MRF571 — G_{Umax} and $|S_{21}|^2$
versus FREQUENCY

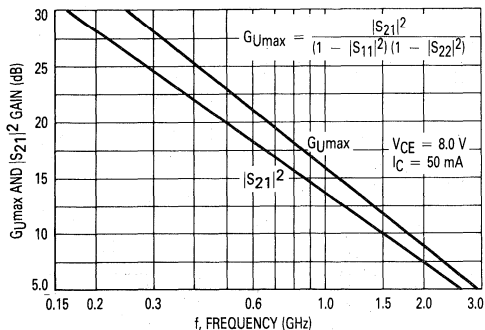
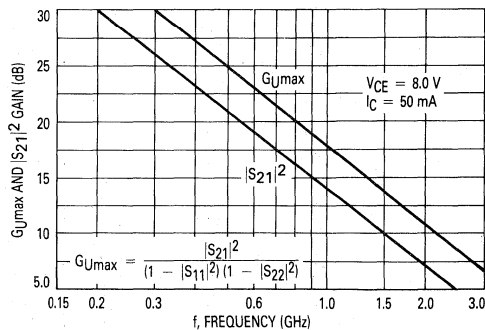
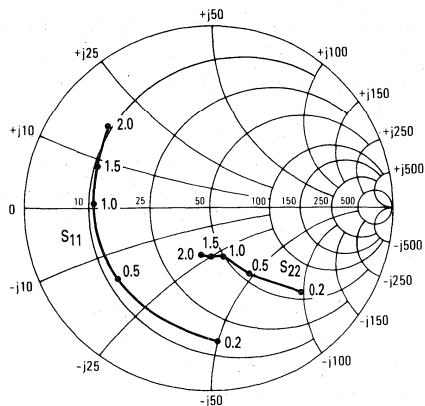


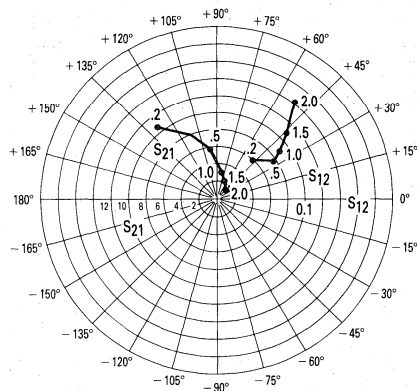
FIGURE 10 — MRF572 — G_{Umax} and $|S_{21}|^2$
versus FREQUENCY



MRF571
INPUT/OUTPUT REFLECTION COEFFICIENTS
versus FREQUENCY (GHz)
 $V_{CE} = 6.0 \text{ V}$, $I_C = 5.0 \text{ mA}$



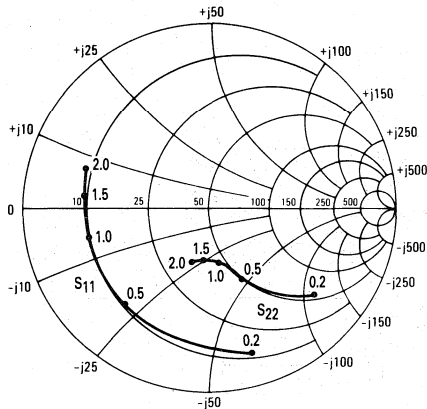
MRF571
FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY (GHz)
 $V_{CE} = 6.0 \text{ V}$, $I_C = 5.0 \text{ mA}$



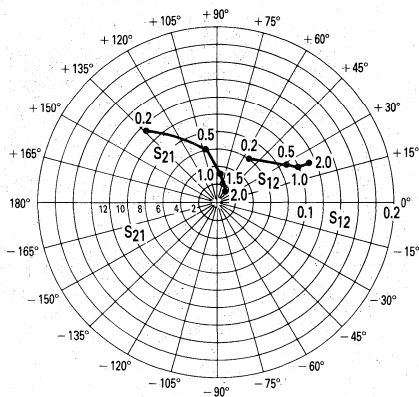
MRF571 COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle \phi$	$|S_{21}|$	$\angle \phi$	$|S_{12}|$	$\angle \phi$	$|S_{22}|$	$\angle \phi$
6.0	5.0	200	0.74	-86	10.5	129	0.06	48	0.69	-42
		500	0.62	-143	5.5	97	0.08	33	0.41	-59
		1000	0.61	178	3.0	78	0.09	37	0.28	-69
		1500	0.65	158	2.0	62	0.11	44	0.26	-88
		2000	0.70	140	1.6	51	0.14	51	0.27	-99
	10	200	0.64	-111	15	118	0.04	44	0.53	-59
		500	0.58	-160	6.9	93	0.06	42	0.27	-77
		1000	0.59	168	3.7	77	0.09	52	0.16	-91
		1500	0.63	151	2.5	64	0.12	56	0.16	-113
		2000	0.67	134	2.0	53	0.16	57	0.16	-118
	50	200	0.56	-160	20.4	102	0.02	57	0.27	-98
		500	0.57	176	8.4	86	0.05	67	0.14	-130
		1000	0.60	156	4.4	75	0.09	70	0.11	-164
		1500	0.62	152	2.9	64	0.13	68	0.13	-175
		2000	0.66	127	2.4	53	0.18	62	0.11	-178
8.0	5.0	200	0.75	-83	10.7	129	0.06	49	0.71	-39
		500	0.62	-140	5.1	98	0.08	34	0.43	-54
		1000	0.60	-179	3.7	78	0.09	38	0.31	-62
		1500	0.64	159	2.1	62	0.10	45	0.29	-80
		2000	0.69	141	1.7	52	0.13	52	0.29	-91
	10	200	0.64	-99	15.1	120	0.05	46	0.54	-60
		500	0.52	-152	7.1	94	0.07	45	0.32	-75
		1000	0.52	170	3.7	76	0.10	54	0.15	-82
		1500	0.52	150	2.5	62	0.13	56	0.16	-108
		2000	0.57	133	2.0	51	0.18	55	0.16	-107
	50	200	0.52	-153	19.6	102	0.03	56	0.28	-92
		500	0.52	178	8.1	86	0.05	67	0.16	-98
		1000	0.56	157	4.1	73	0.10	70	0.06	-130
		1500	0.54	139	2.8	62	0.13	68	0.11	-146
		2000	0.59	126	2.2	52	0.19	63	0.10	-137

MRF572
INPUT/OUTPUT REFLECTION
COEFFICIENTS versus FREQUENCY (GHz)
 $V_{CE} = 6.0 \text{ V}$, $I_C = 5.0 \text{ mA}$



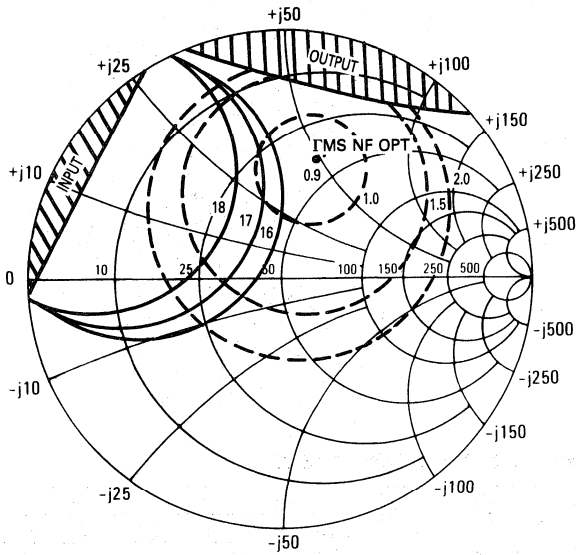
MRF572
FORWARD/REVERSE COEFFICIENTS
versus FREQUENCY (GHz)
 $V_{CE} = 6.0 \text{ V}$, $I_C = 5.0 \text{ mA}$



MRF572 COMMON EMITTER S-PARAMETERS

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	$\angle \phi$	|S21|	$\angle \phi$	|S12|	$\angle \phi$	|S22|	$\angle \phi$
6.0	5.0	200	0.81	-73	10.9	134	0.06	50	0.74	-40
		500	0.68	-130	6.1	102	0.09	29	0.43	-64
		1000	0.66	-167	3.3	79	0.10	22	0.29	-77
		1500	0.66	174	2.3	63	0.10	22	0.27	-94
		2000	0.68	161	1.8	49	0.11	23	0.29	-104
	10	200	0.72	-101	15.9	123	0.05	43	0.57	-58
		500	0.66	-150	7.7	95	0.06	30	0.29	-86
		1000	0.66	-178	4.0	77	0.08	33	0.19	-103
		1500	0.67	166	2.7	63	0.09	36	0.19	-122
		2000	0.69	155	2.1	51	0.10	37	0.20	-129
	50	200	0.67	-154	21.8	104	0.02	43	0.30	-94
		500	0.68	-177	9.0	87	0.03	52	0.17	-129
		1000	0.70	167	4.5	74	0.06	58	0.14	-151
		1500	0.71	157	3.0	62	0.08	59	0.16	-160
		2000	0.73	148	2.3	51	0.10	55	0.17	-161
8.0	5.0	200	0.83	-69	10.9	136	0.06	52	0.75	-36
		500	0.71	-125	6.3	103	0.08	30	0.46	-57
		1000	0.64	-164	3.5	80	0.09	24	0.31	-68
		1500	0.65	176	2.4	63	0.10	23	0.29	-84
		2000	0.66	163	1.8	49	0.11	24	0.30	-94
	10	200	0.74	-94	16.2	125	0.05	45	0.60	-51
		500	0.65	-146	7.9	96	0.06	32	0.31	-74
		1000	0.64	-176	4.2	77	0.07	33	0.20	-87
		1500	0.65	168	2.8	63	0.09	36	0.19	-104
		2000	0.67	156	2.2	50	0.10	37	0.20	-111
	50	200	0.62	-150	22.7	104	0.02	43	0.30	-81
		500	0.64	-174	9.4	86	0.03	51	0.15	-107
		1000	0.68	167	4.8	74	0.05	58	0.10	-126
		1500	0.69	160	3.2	61	0.07	58	0.13	-140
		2000	0.70	147	2.4	50	0.09	55	0.15	-140

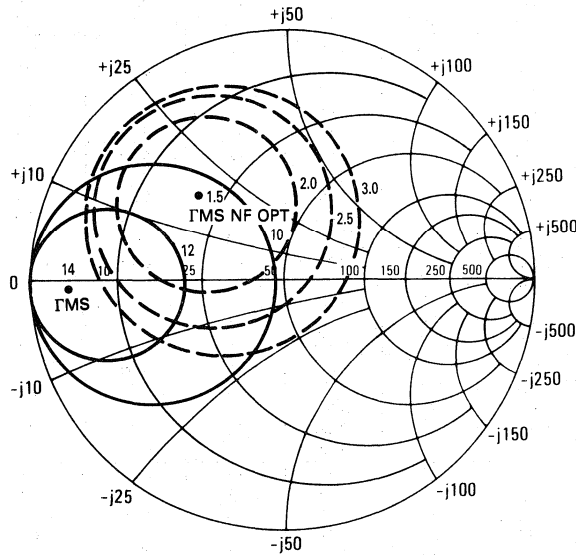
MRF571 — CONSTANT GAIN and NOISE FIGURE CONTOURS



$V_{CE} = 6.0 \text{ V}$, $I_C = 5.0 \text{ mA}$
 $f = 500 \text{ MHz}$
— REGION OF INSTABILITY

f(GHz)	NF OPT(dB)	Rn (Ω)	NF50 Ω (dB)
0.5	0.9	9.3	1.3

Γ_{MS} NF OPT	K
0.49 $\angle 74^\circ$	0.58

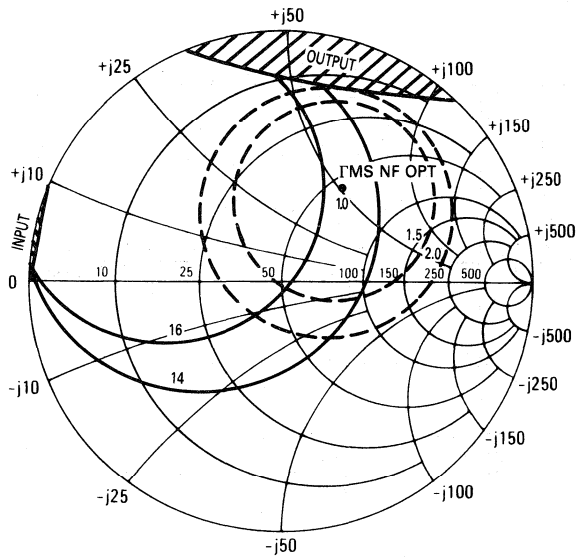


$V_{CE} = 6.0 \text{ V}$, $I_C = 5.0 \text{ mA}$
 $f = 1.0 \text{ GHz}$

f(GHz)	NF OPT(dB)	Rn (Ω)	NF50 Ω (dB)	Γ_{MS} NF OPT
1.0	1.5	7.5	2.2	0.48 $\angle 134^\circ$

Γ_{MS}	Γ_{ML}
0.89 $\angle -179^\circ$	0.81 $\angle 66^\circ$

MRF572 CONSTANT GAIN and NOISE FIGURE CONTOURS



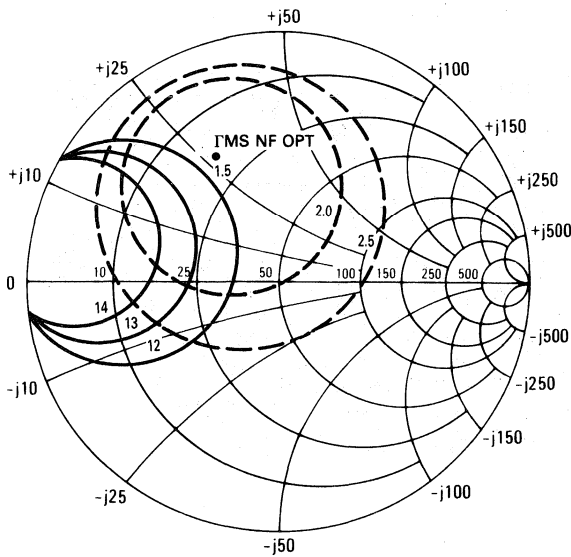
$V_{CE} = 6.0 \text{ V}$, $I = 5.0 \text{ mA}$

$f = 500 \text{ MHz}$

▨ — REGION OF INSTABILITY

f (GHz)	$R_n (\Omega)$	NF (50 Ω)	$\Gamma_{MS NF OPT}$
0.5	17.1	1.5	$0.43 \angle 57^\circ$

K	NF OPT
0.55	1.0



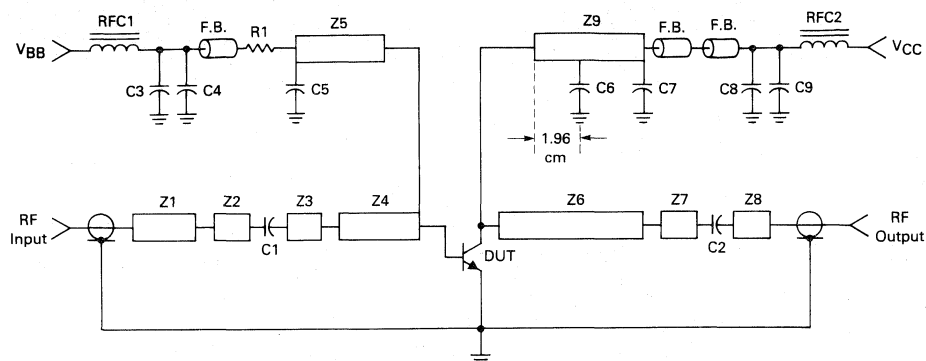
$V_{CE} = 6.0 \text{ V}$, $I_C = 5.0 \text{ mA}$

$f = 1.0 \text{ GHz}$

f (GHz)	NF OPT	$R_n (\Omega)$	NF50 (Ω) (dB)
1.0	1.5	6.0	2.0

$\Gamma_{MS NF OPT}$	K
$0.56 \angle 116^\circ$	0.93

MRF571 1.0 GHz TEST CIRCUIT



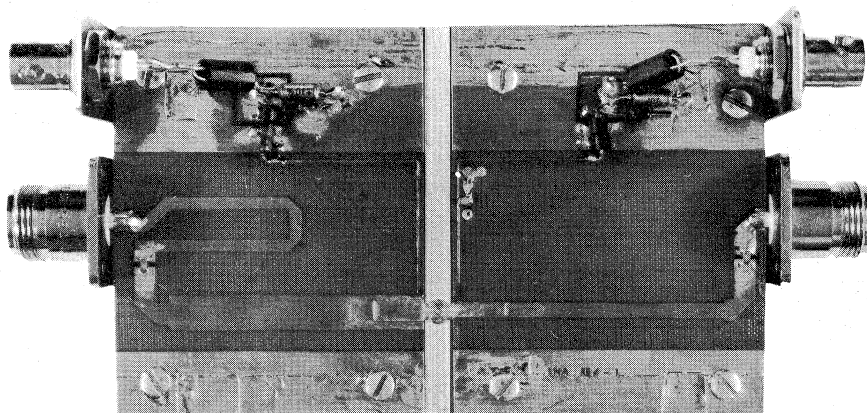
C1, C2, C6
C5, C7
C3, C8
C4, C9
R1

560 pF Chip Capacitor
0.018 μ F Chip Capacitor
0.1 μ F Mylar Capacitor
1.0 μ F Electrolytic Capacitor
2.7 k Ω

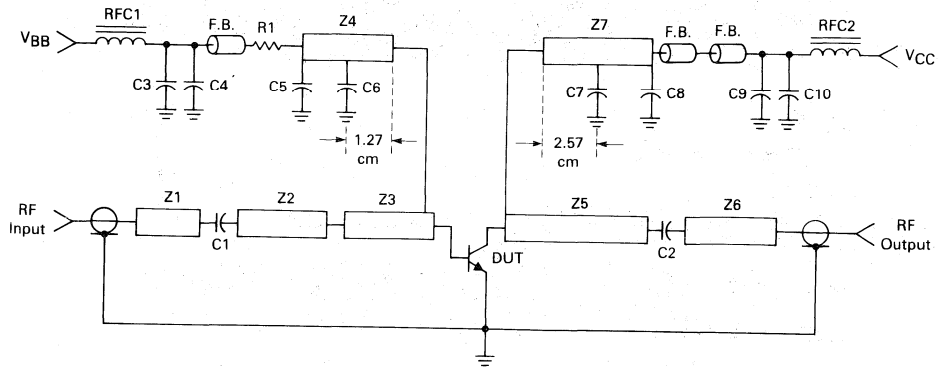
RFC1, RFC2
Z1-Z9
Bead
Board Material

VK-200, Ferroxcube
Microstrip, See Photomaster
Ferrite Bead, Ferroxcube 56-590-65/3B
0.0625" Teflon Fiberglass $\epsilon_r = 2.5 \pm 0.05$

MRF571 TEST CIRCUIT



MRF572, 1.0 GHz TEST CIRCUIT



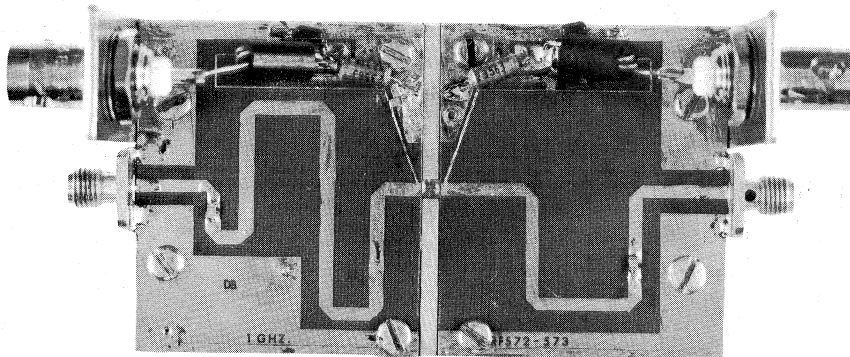
C1, C2, C6, C7
C5, C8
C3, C9
C4, C10
R1

560 pF Chip Capacitor
0.018 μ F Chip Capacitor
0.1 μ F Mylar Capacitor
1.0 μ F Electrolytic Capacitor
2.7 k Ω

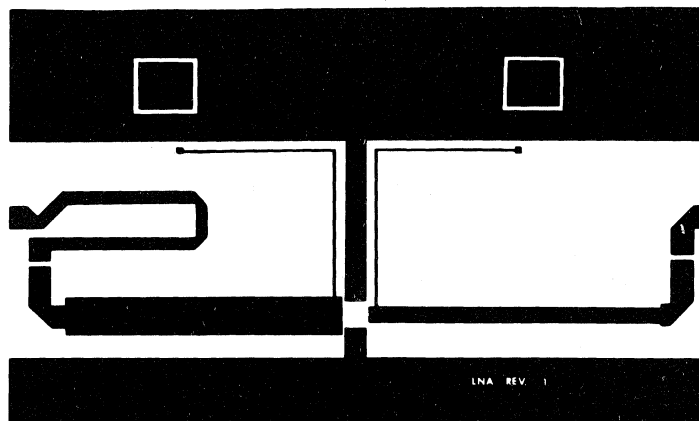
RFC1, RFC2
Z1-Z7
Bead
Board Material

VK-200, Ferroxcube
Microstrip, See Photomaster
Ferrite Bead, Ferroxcube 56-590-65/3B
0.031" Teflon Fiberglass $\epsilon_r = 2.5 \pm 0.05$

MRF572 TEST CIRCUIT

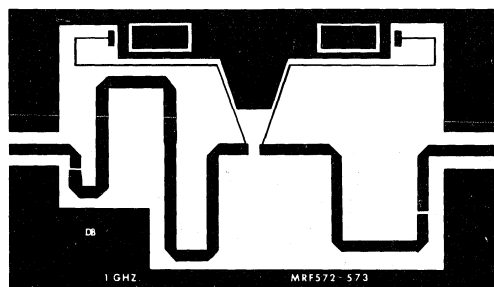


PHOTOMASTER OF MRF571 CIRCUIT LAYOUT



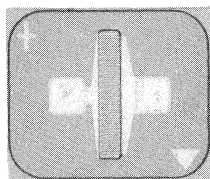
NOTE: The Printed Circuit Board shown is 75% of the original.

PHOTOMASTER OF MRF572 CIRCUIT LAYOUT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRFC572 CHIP TOPOGRAPHY



Nominal Chip Size: 0.015" x 0.016" x 0.005"
 Front Metallization: Gold
 Back Metallization: Gold
 Emitter/Base Bond Pad: 2.2 x 2.2 mil
 #Emitter Fingers: 22
 #Base Fingers: 23
 Emitter Diffusion: Ion-Implanted Arsenic

MRF580,A
MRF581,A
MRFC581,A

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS

... designed for high current low power amplifiers up to 1.0 GHz.




- Low Noise
- Low Intermodulation Distortion
- High Gain
- State-of-the-Art Technology
 - Fine Line Geometry
 - Arsenic Emitters
 - Gold Top Metallization
 - Nicrome Thin-Film Ballasting Resistors
- Excellent Dynamic Range
- Fully Characterized

$f_T = 5.0 \text{ GHz @ } 75 \text{ mA}$
 $NF = 2.0 \text{ dB @ } 500 \text{ MHz}$

HIGH FREQUENCY
TRANSISTORS

NPN SILICON

2

		MRFC581,A		MRF580,A		MRF581,A		
								
		Chip		Case 317A-01 Style 2		Case 317-01 Style 2		
MAXIMUM RATINGS		MRFC581	MRFC581A	MRF580	MRF580A	MRF581	MRF581A	Unit
Collector-Emitter Voltage	V_{CEO}	18	15	18	15	18	15	Vdc
Collector-Base Voltage	V_{CBO}	36	30	36	30	36	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5		2.5		2.5		Vdc
Collector Current — Continuous	I_C	200		200		200		mAdc
Total Device Dissipation @ $T_C = 50^\circ\text{C}(1)$ Derate above $T_C = 50^\circ\text{C}$	P_D	2.5 $T_J = 200^\circ\text{C max}$		2.5 25		2.5 25		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		-65 to +150		-65 to +150		°C

NOTE 1. Case temperature measured on collector lead immediately adjacent to body of package.

MRF580A, MRF581A, MRFC581A

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0)	MRF580/581 MRF580A/581A	V _{(BR)CEO}	18 15	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 1.0 mAdc, I _E = 0)	MRF580/581 MRF580A/581A	V _{(BR)CBO}	36 30	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 0.10 mAdc, I _C = 0)		V _{(BR)EBO}	2.5	—	—	Vdc
Emitter Cutoff Current (V _{EB} = 2.0 Vdc, V _{BE} = 0)		I _{EBO}	—	—	100	μAdc
Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0)		I _{CBO}	—	—	100	μAdc

ON CHARACTERISTICS

DC Current Gain(1) (I _C = 50 mAdc, V _{CE} = 5.0 Vdc)	MRF580/581 MRF580A/581A	h _{FE}	50 90	—	200 250	—
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DYNAMIC CHARACTERISTICS

Collector Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)		C _{cb}	—	1.4	2.0	pF
Current-Gain Bandwidth Product(2) (I _C = 75 mAdc, V _{CE} = 10 Vdc, f = 1.0 GHz)		f _T	—	5.0	—	GHz

FUNCTIONAL TESTS

Noise Figure, Figure 19 (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 0.5 GHz)	MRF580/581 MRF580A/581A	NF	—	2.0 1.8	3.0 2.5	dB
Power Gain at Optimum Noise Figure, Figure 19 (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 0.5 GHz)	MRF580,A	G _{NF}	11	14	—	dB
Power Gain at Optimum Noise Figure, Figure 19 (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 0.5 GHz)	MRF581,A	G _{NF}	13	15.5	—	dB
Maximum Unilateral Gain (I _C = 75 mAdc, V _{CE} = 10 Vdc, f = 0.5 GHz)	MRF580,A(2)	G _{U max}	—	15	—	dB
Maximum Unilateral Gain (I _C = 75 mAdc, V _{CE} = 10 Vdc, f = 0.5 GHz)	MRF581,A(2)	G _{U max}	—	17	—	dB
Intermodulation Distortion, Figure 18 (V _{CE} = 10 V, I _C = 75 mA, V _{out} = +50 dBmV)	MRF581,A(3)	IMD(d3)	—	-65	—	dB

NOTES:

- 300 μs pulse on Tektronix 576 or equivalent.
- Characterized on HP8542 Automatic Network Analyzer.
- 2 Tones, f₁ = 497 MHz, f₂ = 503 MHz, 3rd Order Single Tone reference.

$$G_{Umax} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

FIGURE 1 — C_{ib} INPUT CAPACITANCE versus VOLTAGE

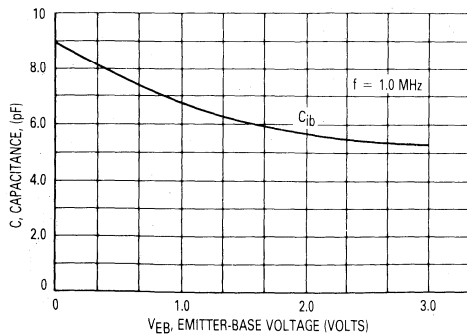


FIGURE 2 — C_{cb}, C_{ob} COLLECTOR-BASE CAPACITANCE versus VOLTAGE

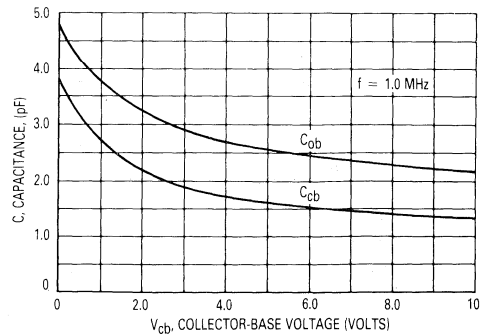


FIGURE 3 — GAIN-BANDWIDTH PRODUCT
versus COLLECTOR CURRENT

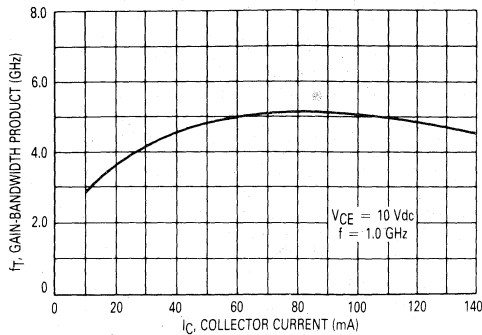
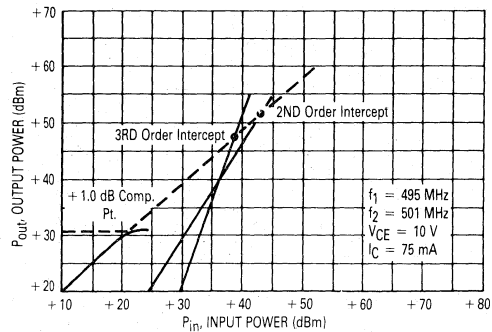


FIGURE 4 — 2ND AND 3RD ORDER INTERCEPT POINTS



MRF580,A TYPICAL PERFORMANCE

FIGURE 5 — $G_{U \max}$ MAXIMUM UNILATERAL GAIN,
 $|S_{21}|^2$ versus FREQUENCY

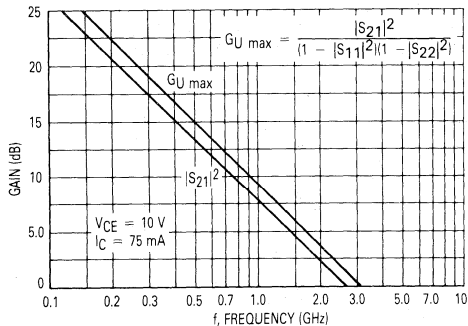


FIGURE 6 — $G_{A \max}$ MAXIMUM AVAILABLE GAIN
versus FREQUENCY

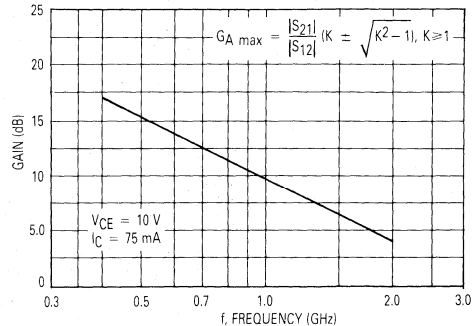


FIGURE 7 — NOISE FIGURE AND GAIN ASSOCIATED
WITH NOISE FIGURE versus FREQUENCY

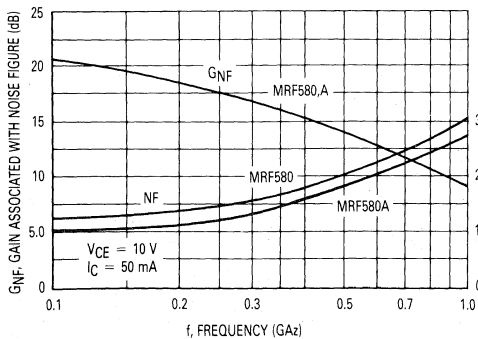
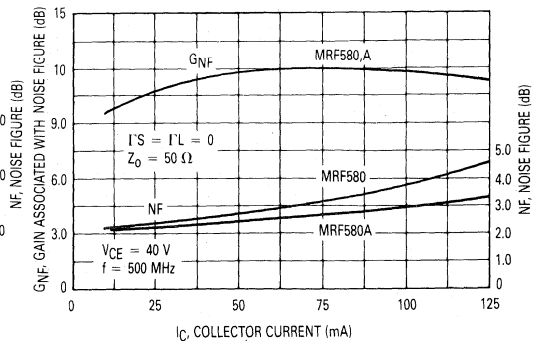
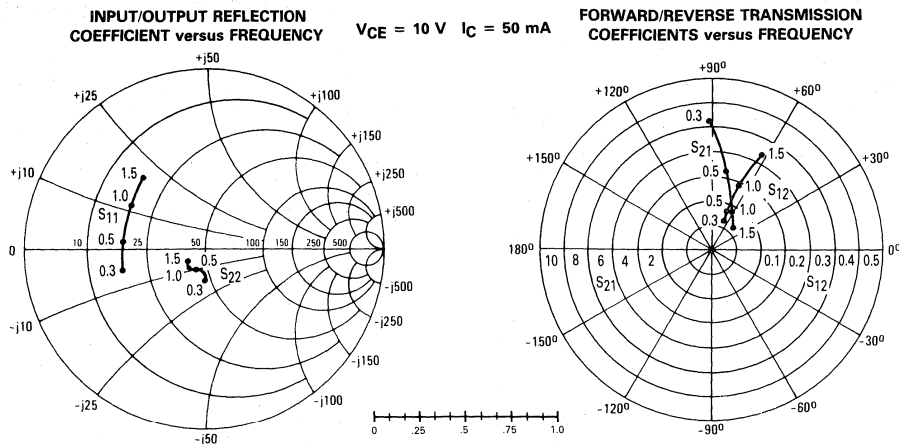


FIGURE 8 — NOISE FIGURE AND GAIN ASSOCIATED
WITH NOISE FIGURE versus COLLECTOR CURRENT



MRF580A, MRF581A, MRFC581A

FIGURE 9 — MRF580A COMMON EMITTER S-PARAMETERS



VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
5.0	25	300	0.49	-170	5.97	91	0.083	60	0.24	-108
		500	0.52	171	3.63	78	0.127	64	0.18	-117
		1000	0.53	149	1.98	58	0.24	66	0.13	-154
		1500	0.56	125	1.46	44	0.35	60	0.19	-172
		300	0.48	-175	6.35	90	0.08	64	0.24	-126
	50	500	0.51	168	3.85	79	0.13	67	0.18	-139
		1000	0.51	148	2.10	59	0.25	66	0.16	-178
		1500	0.54	123	1.56	46	0.36	58	0.20	169
		300	0.48	-177	6.42	90	0.08	65	0.24	-132
	75	500	0.51	167	3.88	79	0.13	67	0.19	-145
		1000	0.50	147	2.12	59	0.26	65	0.17	175
		1500	0.53	123	1.57	46	0.36	58	0.21	164
		300	0.48	-177	6.41	89	0.08	66	0.24	-134
	100	500	0.51	167	3.87	78	0.13	68	0.19	-148
		1000	0.51	146	2.114	59	0.26	65	0.17	172
		1500	0.53	123	1.58	46	0.36	58	0.21	162
		300	0.44	-164	6.67	92	0.07	61	0.25	-76
	25	500	0.47	175	4.08	79	0.11	66	0.19	-75
		1000	0.48	152	2.2	60	0.21	68	0.12	-91
		1500	0.52	126	1.56	45	0.32	64	0.15	-129
		300	0.47	-167	7.40	91	0.07	65	0.17	-89
	50	500	0.47	174	4.53	79	0.11	68	0.12	-112
		1000	0.50	149	2.38	62	0.20	67	0.13	-126
		1500	0.53	131	1.71	47	0.31	63	0.11	-147
		300	0.41	-171	7.24	91	0.07	66	0.20	-96
	75	500	0.45	171	4.39	79	0.12	69	0.13	-99
		1000	0.45	150	2.36	61	0.23	67	0.07	-130
		1500	0.48	125	1.72	47	0.33	61	0.12	-157
		300	0.42	-172	7.22	90	0.07	67	0.19	-97
10	25	500	0.45	170	4.38	78	0.12	69	0.14	-98
		1000	0.45	149	2.35	60	0.23	67	0.07	-129
		1500	0.49	125	1.71	46	0.33	62	0.11	-158
		300	0.48	-159	7.28	93	0.06	60	0.24	-55
	50	500	0.48	-179	4.44	80	0.09	66	0.17	-62
		1000	0.51	153	2.33	62	0.18	68	0.19	-82
		1500	0.54	133	1.67	46	0.27	68	0.17	-97
		300	0.39	-165	7.49	0.92	0.07	65	0.23	-71
	75	500	0.42	174	4.57	80	0.11	69	0.18	-67
		1000	0.43	152	2.44	61	0.21	68	0.11	-74
		1500	0.46	126	1.76	47	0.31	64	0.12	-115
		300	0.39	-167	7.57	91	0.07	66	0.21	-74
	100	500	0.42	173	4.57	79	0.11	70	0.17	-69
		1000	0.42	151	2.45	61	0.21	68	0.09	-75
		1500	0.46	126	1.76	46	0.31	64	0.11	-118
		300	0.39	-168	7.46	90	0.07	67	0.20	-72
	150	500	0.43	172	4.53	78	0.11	70	0.17	-66
		1000	0.43	151	2.41	60	0.21	69	0.10	-71
		1500	0.47	126	1.74	46	0.31	64	0.12	-113

MRF581A TYPICAL PERFORMANCE

FIGURE 10 — $G_{U \max}$ — MAXIMUM UNILATERAL GAIN, $|S_{21}|^2$ versus FREQUENCY

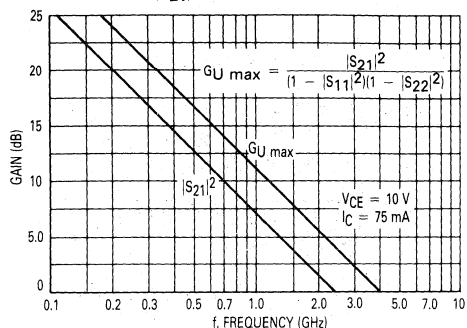


FIGURE 11 — $G_{A \max}$ — MAXIMUM AVAILABLE GAIN versus FREQUENCY

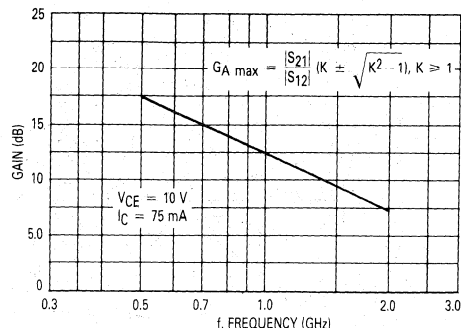


FIGURE 12 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus FREQUENCY

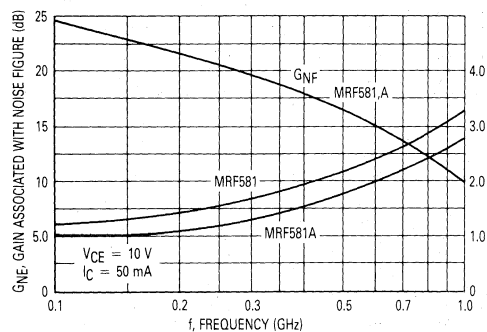


FIGURE 13 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus COLLECTOR CURRENT $f = 500 \text{ MHz}$

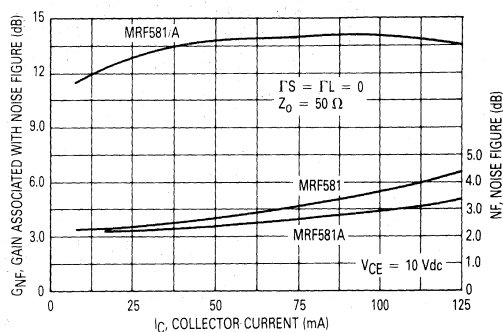


FIGURE 14 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus COLLECTOR CURRENT $f = 200 \text{ MHz}$

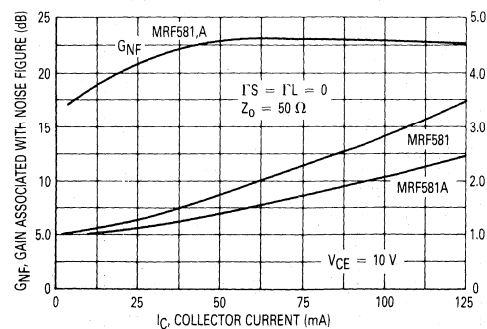


FIGURE 15 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus COLLECTOR CURRENT $f = 50 \text{ MHz}$

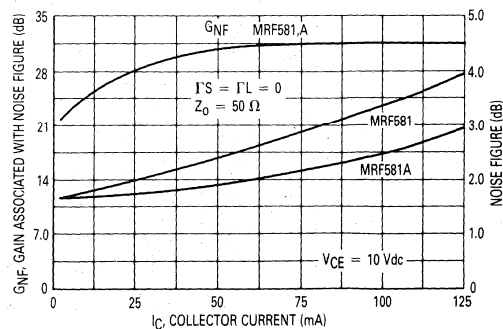
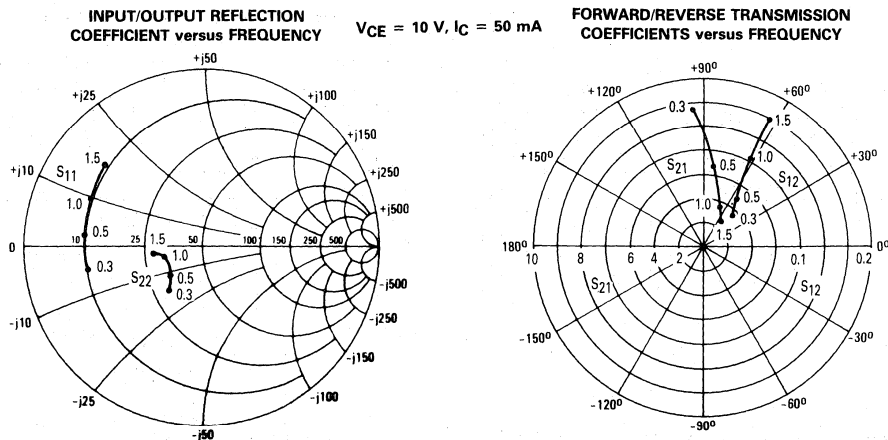


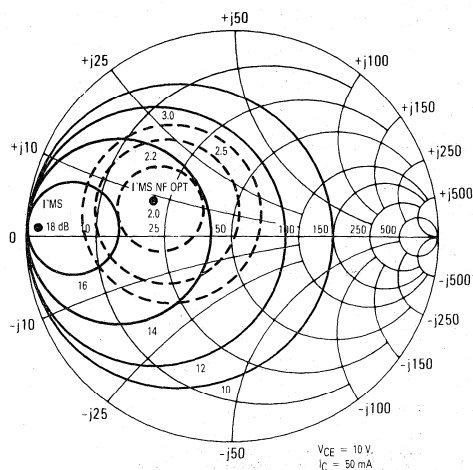
FIGURE 16 — MRF581A COMMON EMITTER S-PARAMETERS



VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	$\angle \phi$	|S21|	$\angle \phi$	|S12|	$\angle \phi$	|S22|	$\angle \phi$
5.0	25	300	0.69	-169	6.57	93	0.06	39	0.34	-129
		500	0.72	176	3.95	82	0.07	47	0.29	-142
		1000	0.73	157	2.10	62	0.12	60	0.27	-165
		1500	0.76	139	1.47	50	0.17	61	0.33	-172
	50	300	0.70	-173	7.14	93	0.05	45	0.38	-144
		500	0.72	173	4.27	82	0.07	53	0.34	-157
		1000	0.72	157	2.24	65	0.13	62	0.33	-179
		1500	0.76	138	1.61	53	0.18	61	0.37	-173
	75	300	0.70	-175	7.26	92	0.05	48	0.40	-148
		500	0.72	172	4.33	82	0.07	55	0.36	-161
		1000	0.72	155	2.28	65	0.13	63	0.35	-176
		1500	0.76	138	1.64	53	0.19	61	0.39	-170
	100	300	0.70	-176	7.30	92	0.05	48	0.40	-151
		500	0.72	172	4.34	82	0.07	56	0.37	-163
		1000	0.72	155	2.28	65	0.13	63	0.362	-175
		1500	0.75	137	1.64	53	0.19	61	0.39	-168
10	25	300	0.66	-165	7.58	95	0.05	40	0.29	-106
		500	0.69	178	4.56	82	0.07	48	0.23	-116
		1000	0.70	159	2.39	64	0.11	61	0.19	-141
		1500	0.74	141	1.65	50	0.16	64	0.26	-153
	50	300	0.65	-169	8.25	94	0.05	46	0.30	-126
		500	0.68	175	4.96	82	0.07	54	0.24	-138
		1000	0.69	157	2.60	65	0.12	63	0.22	-164
		1500	0.72	139	1.82	52	0.17	63	0.27	-171
	75	300	0.66	-171	8.49	93	0.05	48	0.30	-132
		500	0.68	175	5.06	82	0.07	55	0.25	-145
		1000	0.69	157	2.64	65	0.12	64	0.23	-170
		1500	0.72	139	1.86	53	0.17	63	0.27	-176
	100	300	0.66	-172	8.46	93	0.05	49	0.30	-134
		500	0.68	174	5.06	82	0.07	56	0.25	-147
		1000	0.68	157	2.64	65	0.12	64	0.23	-172
		1500	0.72	139	1.86	52	0.17	63	0.27	-177
15	25	300	0.65	-163	7.96	95	0.05	40	0.28	-92
		500	0.67	179	4.82	82	0.06	48	0.21	-98
		1000	0.68	160	2.51	63	0.10	62	0.17	-119
		1500	0.72	141	1.73	49	0.16	65	0.24	-137
	50	300	0.64	-167	8.76	94	0.0	46	0.26	-112
		500	0.66	177	5.37	82	0.06	54	0.20	-122
		1000	0.67	159	2.75	65	0.11	64	0.16	-148
		1500	0.71	141	1.91	51	0.16	64	0.22	-157
	75	300	0.64	-168	8.93	93	0.05	47	0.25	-117
		500	0.66	176	5.34	82	0.06	55	0.20	-128
		1000	0.69	158	2.78	65	0.11	65	0.16	-154
		1500	0.70	140	1.93	51	0.16	64	0.22	-162
	100	300	0.64	-169	8.91	93	0.05	48	0.25	-117
		500	0.66	176	5.33	82	0.6	56	0.19	-129
		1000	0.67	158	2.78	64	0.11	65	0.16	-154
		1500	0.70	140	1.93	51	0.16	64	0.21	-160

MRF580A, MRF581A, MRFC581A

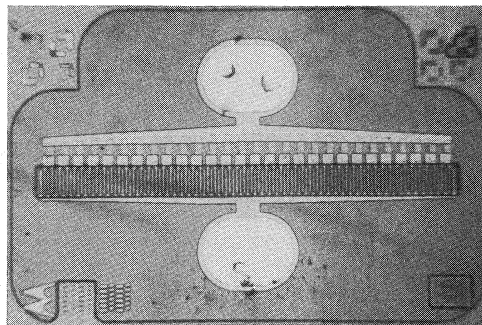
FIGURE 17 — MRF581 CONSTANT GAIN
CONTOURS NOISE FIGURE CONTOURS



f (MHz)	Γ_{MS}	Γ_{ML}	Γ_{MS} NF OPT	$G_{A MAX}$ (dB)	R_n (Ω)	NF OPT	NF (50 Ω)
500	0.91/176°	0.78/77°	0.39/158°	18	10.5	2.0	2.5

Circuit Per Figure 18

MRFC581A CHIP TOPOGRAPHY



Nominal Chip Size: 0.017" X 0.027" X 0.005"
Front Metallization: Gold
Back Metallization: Gold
Emitter/Base Bond Pad: 0.003" X 0.004"
#Emitter Fingers: 56
#Base Fingers: 57
Emitter Diffusion: Ion-Implanted Arsenic
Fabrication: Fully Ion Implanted
Ballasting: NiCr Resistor
Passivation: Silicon Nitride

FIGURE 18 — MRF580,A/581,A TEST FIXTURE SCHEMATIC
500 MHz

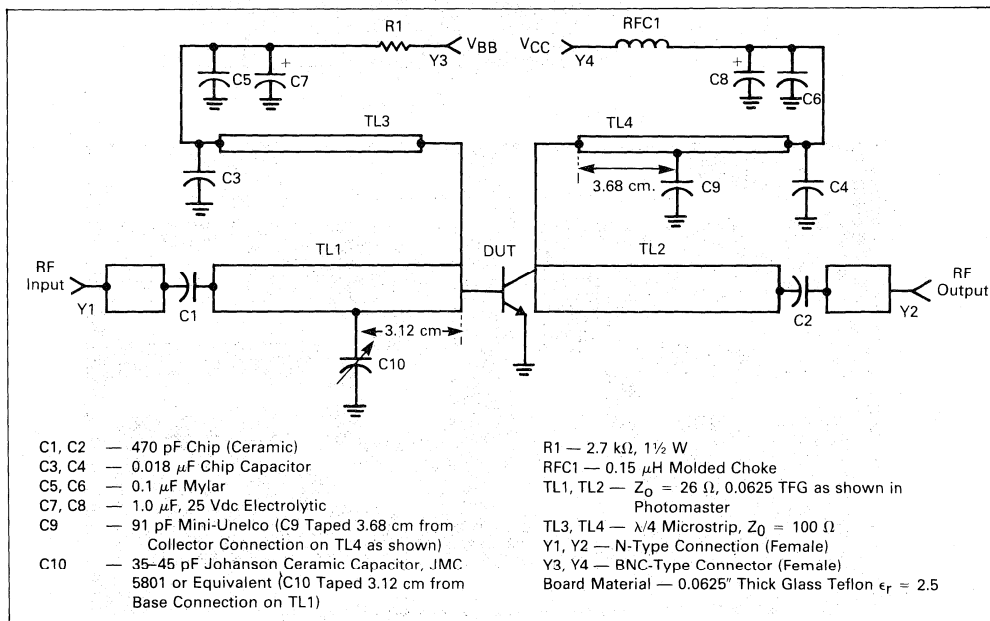


FIGURE 19 — FUNCTIONAL CIRCUIT SCHEMATIC

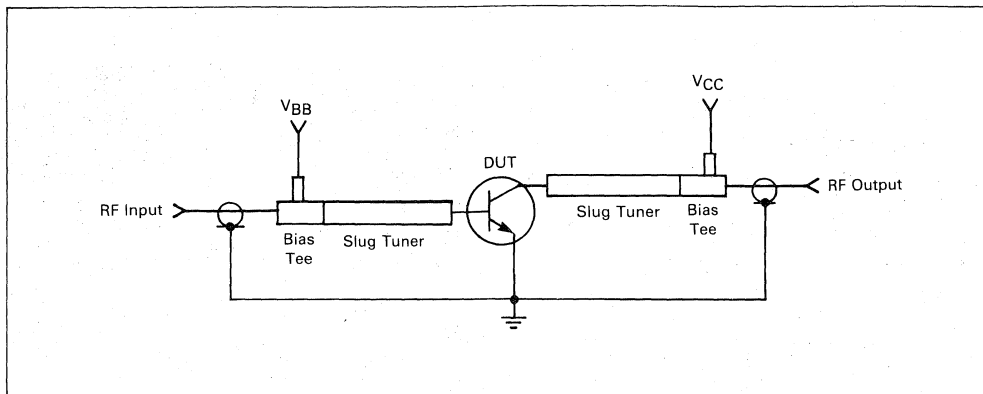


FIGURE 20 — MRF580,A/581,A TEST CIRCUIT

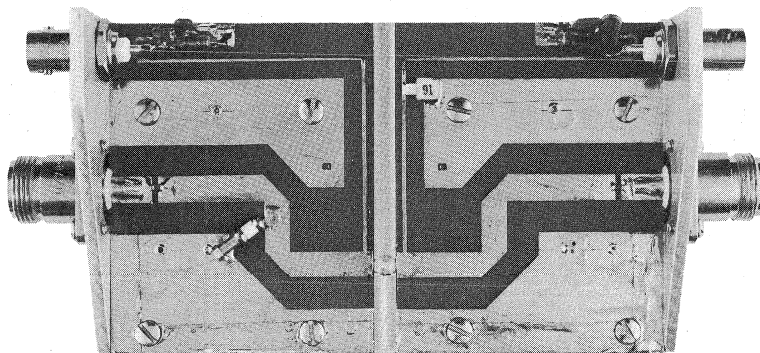
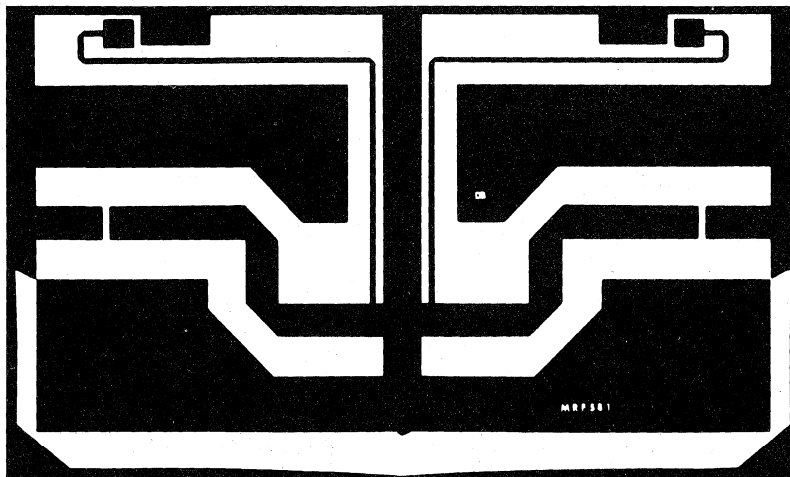


FIGURE 21 — PC BOARD PHOTOMASTER



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF586
MRF587

Designer's Data Sheet

The RF Line

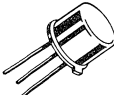
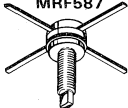
NPN SILICON HIGH FREQUENCY TRANSISTORS

... designed for use in high-gain, low-noise, ultra-linear, tuned and wideband amplifiers. Ideal for use in CATV, MATV, and instrumentation applications.

- Low Noise Figure —
 $NF = 3.0 \text{ dB (Typ) @ } f = 500 \text{ MHz, } I_C = 90 \text{ mA}$
- High Power Gain —
 $G_{U(\text{max})} = 16.5 \text{ dB (Typ) @ } f = 500 \text{ MHz}$
- Ion Implanted
- All Gold Metal System
- High f_T —4.5 GHz MRF586
5.5 GHz MRF587
- Low Intermodulation Distortion:
 $TB_3 = -70 \text{ dB}$
 $DIN = 125 \text{ dB } \mu\text{V}$

$NF = 3.0 \text{ dB @ } 0.5 \text{ GHz}$

**HIGH FREQUENCY
TRANSISTORS**
NPN SILICON

MAXIMUM RATINGS		 MRF586 Case 79-04 Style 1		 MRF587 Case 244A-01 Style 1	
		Values		Unit	
Collector-Emitter Voltage	V_{CEO}	17	17	Vdc	
Collector-Base Voltage	V_{CBO}	34	34	Vdc	
Emitter-Base Voltage	V_{EBO}	2.5	2.5	Vdc	
Collector Current — Continuous	I_C	200	200	mAdc	
Total Device Dissipation @ $T_C = 50^\circ\text{C}$ Derate above $T_C = 50^\circ\text{C}$	P_D	2.5 17	5.0 33	Watts mW/ $^\circ\text{C}$	
Storage Temperature Range	T_{stg}	-65 to +200	-65 to +150	$^\circ\text{C}$	
Junction Temperature	T_J	200	200	$^\circ\text{C}$	

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	17	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1.0\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	34	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_C = 0$, $I_E = 0.1\text{ mA}$)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	50	μAdc
ON CHARACTERISTICS					
DC Current Gain (1) ($I_C = 50\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (2) ($I_C = 90\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 0.5\text{ GHz}$)	MRF586 MRF587 f_T	— —	4.5 5.5	— —	GHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{cb}	—	1.7	2.2	pF
FUNCTIONAL TESTS					
Narrow Band — Figure 23 ($I_C = 90\text{ mA}$, $V_{CC} = 15\text{ V}$, $f = 0.5\text{ GHz}$)					dB
Noise Figure	MRF586	—	3.0	4.0	
Power Gain at Optimum Noise Figure	MRF587	9.0 11.0	11.0 13.0	—	
Broad Band — Figures 24 and 25 ($I_C = 90\text{ mA}$, $V_{CC} = 15\text{ V}$, $f = 0.3\text{ GHz}$)					dB
Noise Figure	MRF586 MRF587	— —	5.5 6.3	— —	
Power Gain at Optimum Noise Figure	MRF586 MRF587	— —	10.0 11.0	— —	
Triple Beat Distortion ($I_C = 50\text{ mA}$, $V_{CC} = 15\text{ V}$, $P_{Ref} = 50\text{ dBmV}$) ($I_C = 90\text{ mA}$, $V_{CC} = 15\text{ V}$, $P_{Ref} = 50\text{ dBmV}$)	MRF586 MRF587	— —	-65 -70	— —	dB
DIN 45004 ($I_C = 90\text{ mA}$, $V_{CC} = 15\text{ V}$) ($I_C = 90\text{ mA}$, $V_{CC} = 15\text{ V}$)	MRF586 MRF587	— —	120 125	— —	dB μV
Maximum Available Power Gain (3) ($I_C = 90\text{ mA}$, $V_{CE} = 15\text{ Vdc}$, $f = 0.5\text{ GHz}$)	MRF586 MRF587	— —	14.5 16.5	— —	dB

NOTES:

- 300 μs pulse on Tektronix 576 or equivalent.
- Characterized on HP8542 Automatic Network Analyzer.

$$3 \quad G_{Umax} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

FIGURE 1 — TYPICAL NOISE FIGURE AND ASSOCIATED GAIN versus FREQUENCY

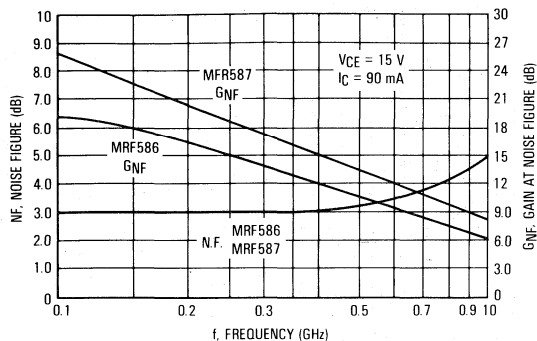


FIGURE 2 — NOISE FIGURE versus COLLECTOR CURRENT

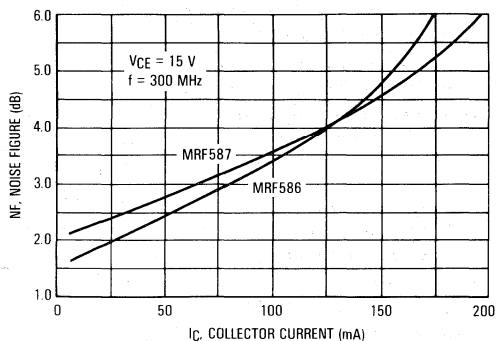


FIGURE 3 — G_{Umax} versus COLLECTOR CURRENT

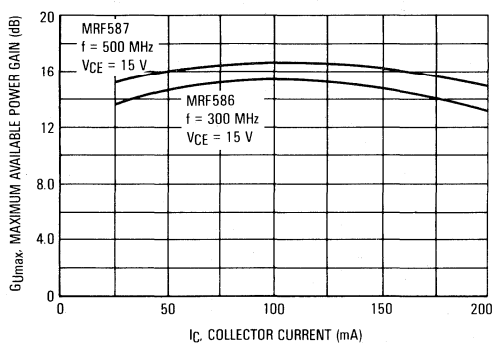
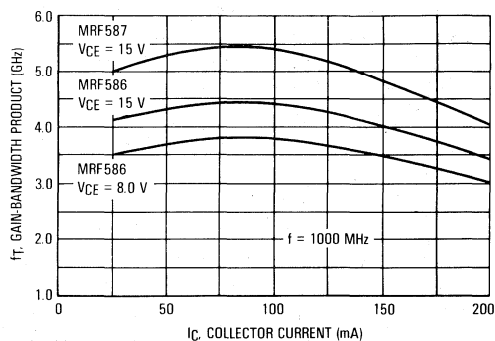


FIGURE 4 — GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT



MRF586 TYPICAL PERFORMANCE

FIGURE 5 — BROADBAND NOISE FIGURE MRF586

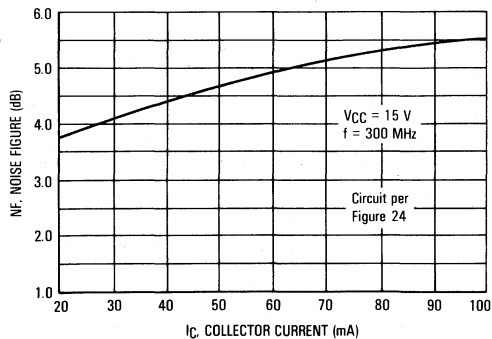
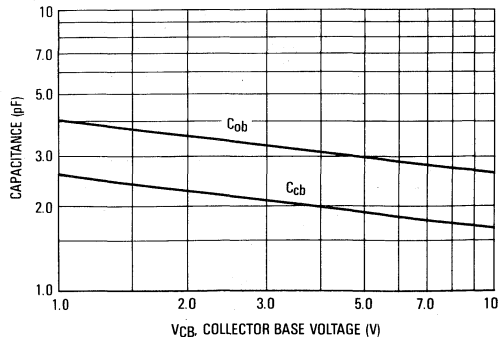


FIGURE 6 — JUNCTION CAPACITANCE versus VOLTAGE MRF586



MRF586 TYPICAL PERFORMANCE (continued)

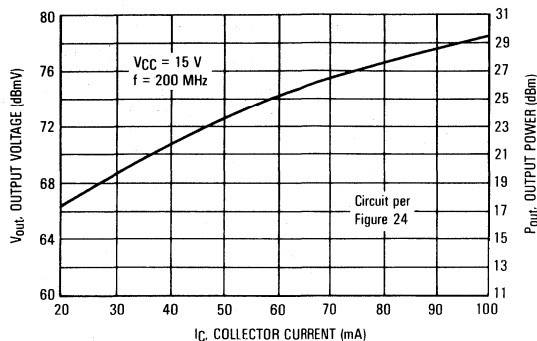
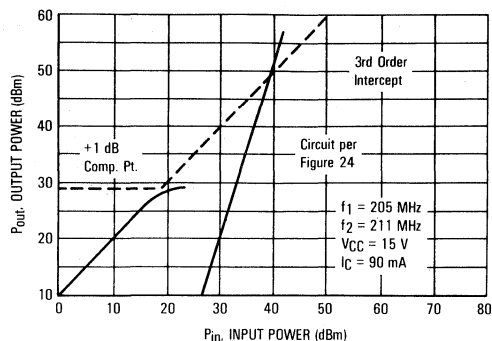
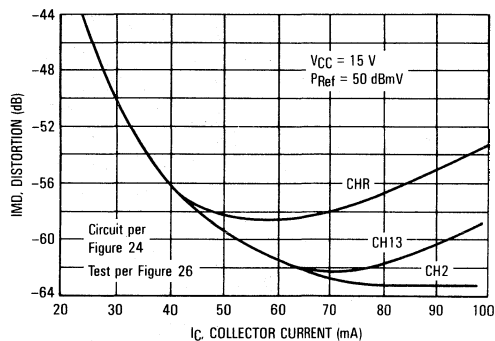
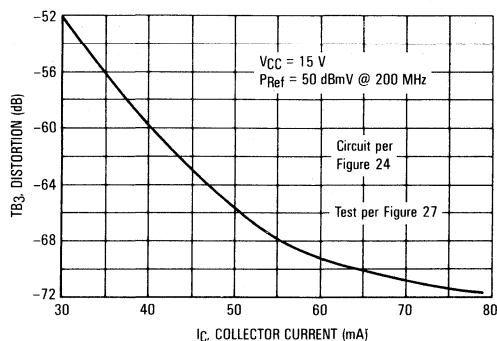
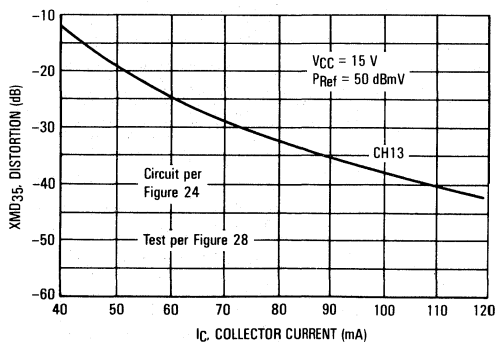
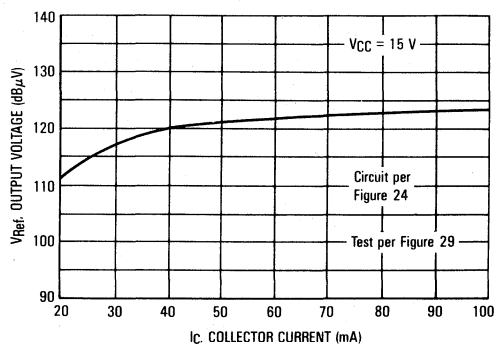
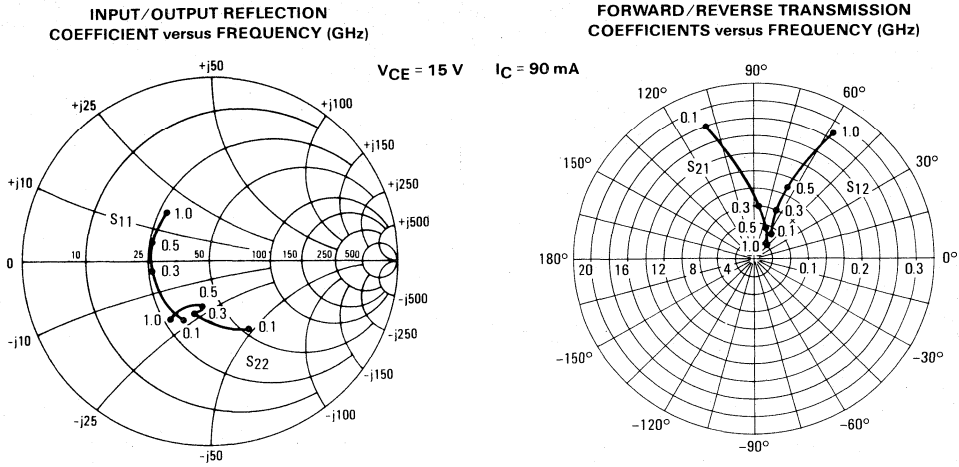
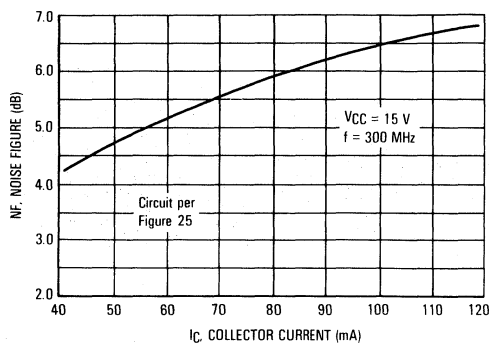
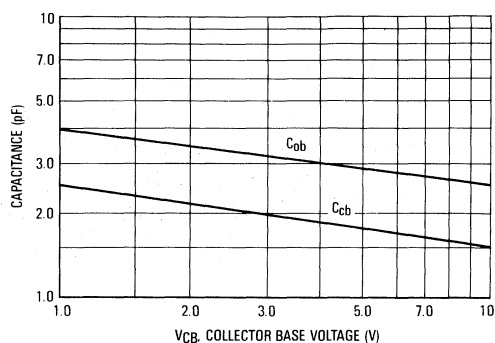
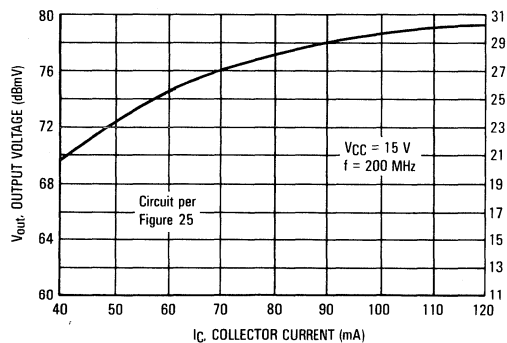
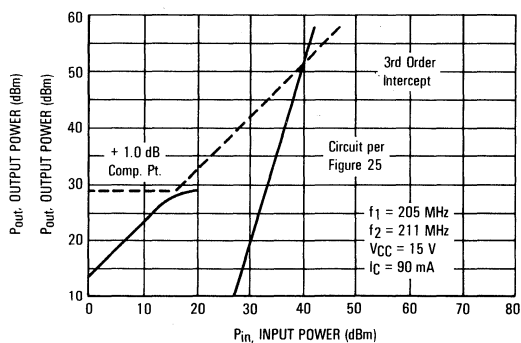
FIGURE 7 — 1.0 dB COMPRESSION POINT versus COLLECTOR CURRENT
MRF586FIGURE 8 — THIRD ORDER INTERCEPT POINT
MRF586FIGURE 9 — SECOND ORDER DISTORTION versus COLLECTOR CURRENT
MRF586FIGURE 10 — TRIPLE BEAT DISTORTION versus COLLECTOR CURRENT
MRF586FIGURE 11 — 35-CHANNEL X-MODULATION DISTORTION versus COLLECTOR CURRENT
MRF586FIGURE 12 — $DIN45004B$ versus COLLECTOR CURRENT
MRF586

FIGURE 13 — MRF586 COMMON-EMITTER S-PARAMETERS



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle\phi$	$|S_{21}|$	$\angle\phi$	$|S_{12}|$	$\angle\phi$	$|S_{22}|$	$\angle\phi$
5.0	30	100	0.42	-122	13.45	109	0.05	54	0.45	-74
		300	0.39	-175	5.10	84	0.09	58	0.30	-105
		500	0.41	162	3.11	71	0.16	60	0.32	-125
		1000	0.42	131	1.68	47	0.28	56	0.38	-138
	60	100	0.39	-131	14.35	106	0.05	56	0.41	-84
		300	0.37	180	5.27	83	0.11	62	0.28	-130
		500	0.39	158	3.22	72	0.17	62	0.32	-134
		1000	0.39	127	1.75	49	0.29	55	0.36	-144
	90	100	0.39	-134	14.45	106	0.05	56	0.42	-87
		300	0.38	176	5.27	82	0.11	60	0.33	-132
		500	0.39	155	3.19	70	0.16	59	0.37	-136
		1000	0.36	120	1.70	43	0.28	49	0.45	-143
10	30	100	0.41	-112	14.40	111	0.05	55	0.48	-63
		300	0.35	-170	5.51	85	0.10	60	0.28	-100
		500	0.37	164	3.35	72	0.15	61	0.32	-109
		1000	0.38	132	1.79	47	0.26	58	0.40	-125
	60	100	0.37	-119	15.35	109	0.05	58	0.43	-70
		300	0.33	-174	5.76	84	0.10	62	0.26	-103
		500	0.35	160	3.50	73	0.16	62	0.31	-117
		1000	0.36	128	1.88	49	0.27	57	0.37	-130
	90	100	0.36	-123	15.68	107	0.05	57	0.44	-77
		300	0.33	180	5.78	83	0.10	61	0.32	-117
		500	0.34	154	3.44	70	0.15	59	0.39	-122
		1000	0.31	118	1.84	43	0.25	51	0.49	-133
15	30	100	0.42	-107	14.72	111	0.05	55	0.49	-58
		300	0.33	-167	5.64	85	0.09	60	0.28	-92
		500	0.35	166	3.48	73	0.14	61	0.32	-102
		1000	0.37	133	1.82	47	0.25	59	0.40	-119
	60	100	0.37	-112	15.80	109	0.05	57	0.45	-64
		300	0.31	-171	5.90	85	0.10	63	0.26	-100
		500	0.33	162	3.60	73	0.15	63	0.30	-108
		1000	0.35	130	1.92	49	0.27	58	0.38	-124
	90	100	0.37	-114	16.04	109	0.05	56	0.45	-67
		300	0.31	-173	5.96	84	0.10	61	0.30	-108
		500	0.32	155	3.56	70	0.15	61	0.35	-114
		1000	0.33	120	1.84	45	0.25	55	0.44	-127

MRF587 TYPICAL PERFORMANCE

FIGURE 14 — BROADBAND NOISE FIGURE
MRF587FIGURE 15 — JUNCTION CAPACITANCE versus VOLTAGE
MRF587FIGURE 16 — 1.0 dB COMPRESSION POINT versus
COLLECTOR CURRENT
MRF587FIGURE 17 — THIRD ORDER INTERCEPT POINT
MRF587

MRF587 TYPICAL PERFORMANCE (continued)

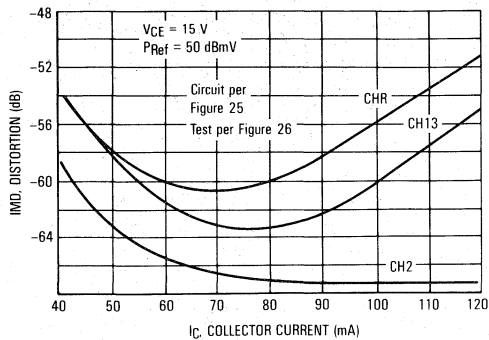
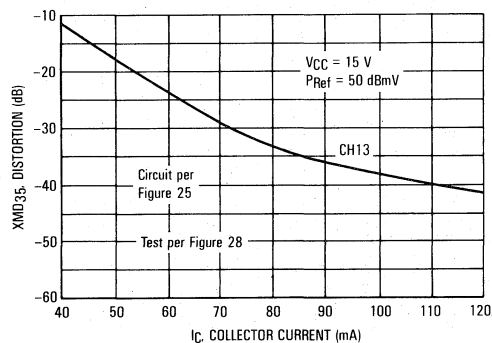
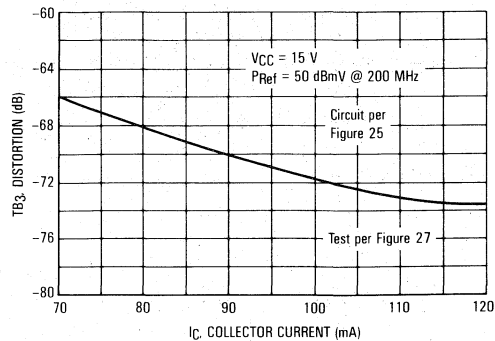
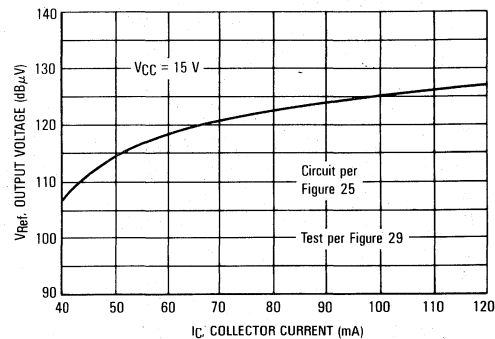
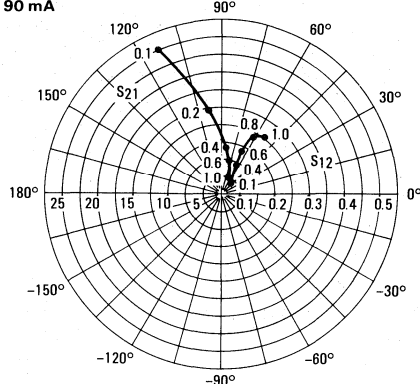
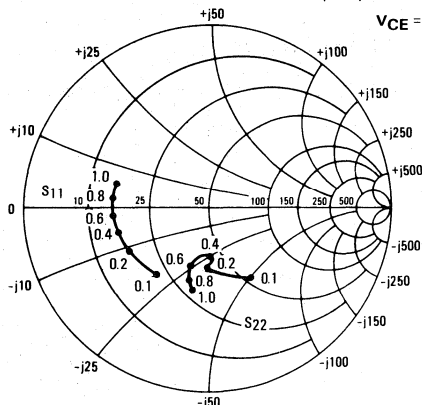
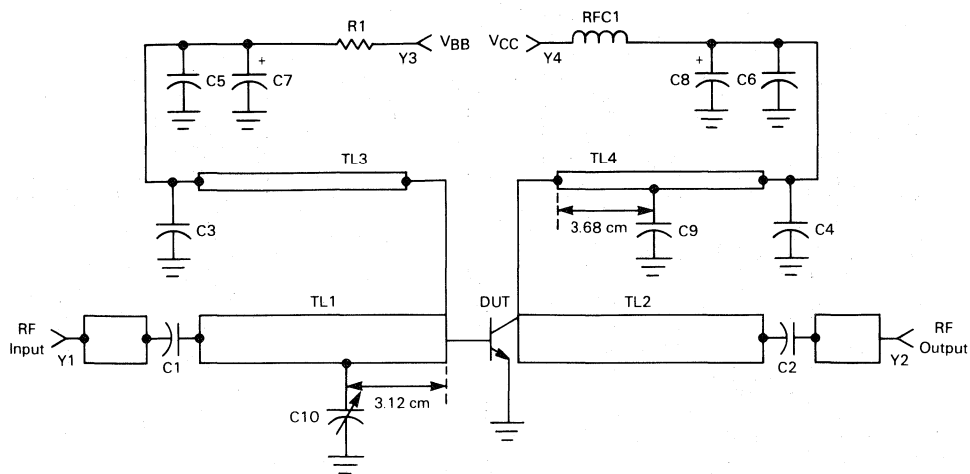
FIGURE 18 — SECOND ORDER DISTORTION versus COLLECTOR CURRENT
MRF587FIGURE 20 — 35-CHANNEL X-MODULATION DISTORTION versus COLLECTOR CURRENT
MRF587FIGURE 19 — TRIPLE BEAT DISTORTION versus COLLECTOR CURRENT
MRF587FIGURE 21 — DIN 45004B versus COLLECTOR CURRENT
MRF587

FIGURE 22 — MRF587 COMMON-EMITTER S-PARAMETERS

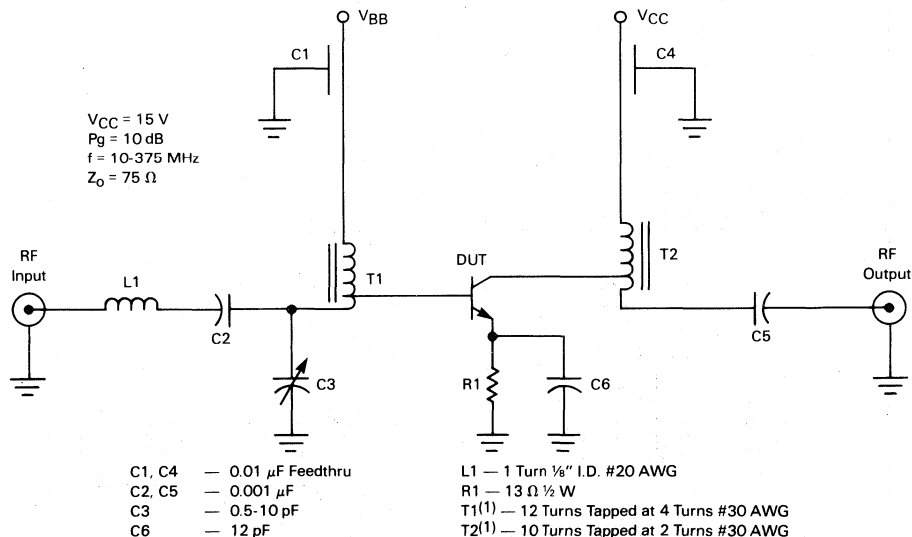
INPUT/OUTPUT REFLECTION
COEFFICIENT versus FREQUENCY (GHz)FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY (GHz) $V_{CE} = 15\text{ V}$ $I_C = 90\text{ mA}$ 

V_{CE} (Volts)	I_C (mA)	Freq (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle\phi$	$|S_{21}|$	$\angle\phi$	$|S_{12}|$	$\angle\phi$	$|S_{22}|$	$\angle\phi$
5.0	30	100	0.56	-131	16.45	113	0.04	45	0.49	-91
		200	0.58	-159	9.42	98	0.06	49	0.38	-116
		400	0.60	-178	5.00	86	0.08	55	0.35	-132
		600	0.64	170	3.61	76	0.11	56	0.38	-138
		800	0.67	162	2.92	67	0.14	55	0.41	-144
		1000	0.70	155	2.55	58	0.17	54	0.44	-152
	60	100	0.53	-141	17.89	110	0.04	50	0.47	-102
		200	0.56	-164	10.05	97	0.05	55	0.39	-126
		400	0.59	178	5.31	85	0.09	60	0.38	-141
		600	0.63	169	3.82	76	0.12	59	0.40	-146
		800	0.66	161	3.09	67	0.15	57	0.44	-153
		1000	0.69	155	2.67	58	0.18	55	0.47	-160
	90	100	0.52	-145	18.26	109	0.04	52	0.47	-106
		200	0.56	-166	10.20	96	0.05	57	0.39	-130
		400	0.59	177	5.38	85	0.09	62	0.39	-144
		600	0.63	168	3.86	76	0.12	60	0.41	-149
		800	0.66	161	3.12	67	0.15	58	0.45	-155
		1000	0.69	155	2.70	58	0.19	55	0.48	-162
10	30	100	0.53	-122	18.36	115	0.04	48	0.50	-75
		200	0.53	-153	10.63	100	0.05	51	0.36	-96
		400	0.55	175	5.71	87	0.08	57	0.33	-112
		600	0.59	173	4.16	78	0.10	58	0.35	-119
		800	0.62	165	3.37	68	0.13	57	0.39	-127
		1000	0.65	158	2.95	59	0.15	55	0.42	-136
	60	100	0.49	-132	20.19	112	0.03	51	0.46	-85
		200	0.51	-158	11.54	99	0.05	57	0.35	-107
		400	0.53	-178	6.12	87	0.08	61	0.33	-123
		600	0.58	171	4.43	78	0.11	60	0.36	-129
		800	0.60	164	3.58	68	0.14	59	0.40	-136
		1000	0.63	157	3.12	60	0.16	57	0.44	-144
	90	100	0.48	-135	20.82	111	0.03	53	0.45	-88
		200	0.50	-160	11.77	98	0.05	59	0.34	-111
		400	0.53	-179	6.22	86	0.08	63	0.33	-126
		600	0.57	171	4.50	78	0.11	62	0.36	-131
		800	0.60	164	3.64	68	0.14	59	0.41	-139
		1000	0.63	157	3.18	60	0.17	57	0.44	-147
15	30	100	0.49	-112	20.34	118	0.04	54	0.51	-52
		200	0.52	-145	11.51	101	0.05	56	0.36	-77
		400	0.48	-164	6.12	87	0.09	63	0.32	-74
		600	0.52	-174	4.19	75	0.12	62	0.32	-90
		800	0.53	177	3.29	68	0.16	61	0.38	-90
		1000	0.53	168	2.76	61	0.20	56	0.47	-90
	60	100	0.45	-122	22.14	115	0.03	56	0.45	-60
		200	0.49	-150	12.24	99	0.05	60	0.33	-86
		400	0.45	-166	6.45	86	0.09	65	0.30	-83
		600	0.50	-175	4.42	75	0.13	63	0.32	-99
		800	0.51	177	3.47	68	0.16	61	0.38	-98
		1000	0.51	168	2.91	62	0.20	55	0.46	-96
	90	100	0.44	-127	22.76	114	0.03	58	0.43	-62
		200	0.48	-152	12.44	98	0.05	62	0.32	-89
		400	0.44	-167	6.55	85	0.09	66	0.29	-85
		600	0.50	-176	4.47	75	0.13	64	0.32	-102
		800	0.51	176	3.51	69	0.17	61	0.38	-100
		1000	0.51	168	2.95	62	0.20	55	0.46	-98

FIGURE 23 — MRF586/587 NARROW BAND TEST FIXTURE SCHEMATIC
500 MHz

- C1, C2 — 470 pF Chip (Ceramic)
 C3, C4 — 0.018 μ F Chip Capacitor
 C5, C6 — 0.1 μ F Mylar
 C7, C8 — 1.0 μ F, 25 Vdc Electrolytic
 C9 — 91 pF Mini-Unelco (C9 Taped 3.68 cm from Collector Connection on TL4 as shown)
 C10 — 35-45 pF Johanson Cerami Capacitor, JMC 5801 or Equivalent (C10 Taped 3.12 cm from Base Connection on TL1)
- R1 — 2.7 k Ω , 1 $\frac{1}{2}$ W
 RFC1 — 0.15 μ H Molded Choke
 TL1, TL2 — $Z_0 = 26 \Omega$, 0.0625 IFG as shown in Photomaster
 TL3, TL4 — $\lambda/4$ Microstrip, $Z_0 = 100 \Omega$
 Y1, Y2 — N-Type Connection (Female)
 Y3, Y4 — BNC-Type Connector (Female)
 Board Material — 0.0625" Thick Glass Teflon $\epsilon_r = 2.5$

FIGURE 24 — MRF586 BROADBAND TEST CIRCUIT SCHEMATIC



(1) Ferronics 12-340-k Core

FIGURE 25 — MRF587 BROADBAND TEST CIRCUIT SCHEMATIC

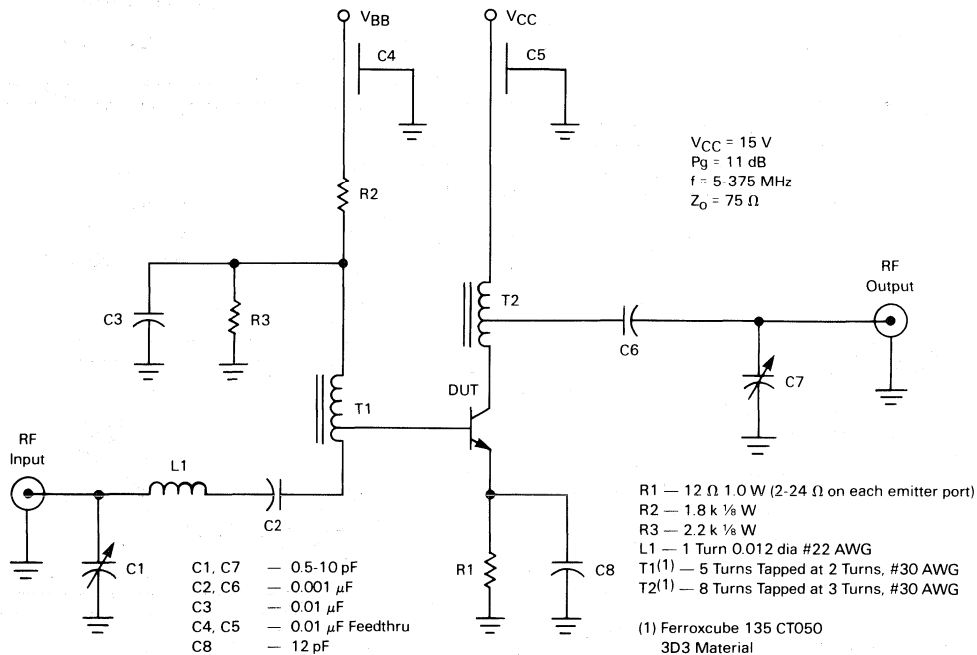


FIGURE 26 — SECOND ORDER DISTORTION TEST

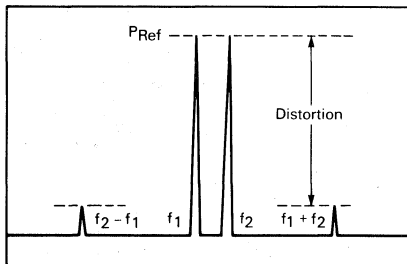


FIGURE 28 — CROSSMODULATION DISTORTION TEST

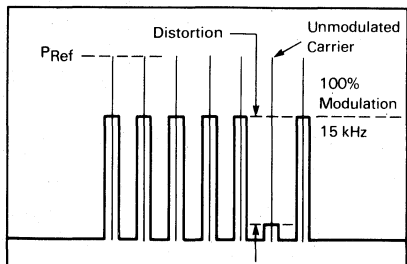


FIGURE 27 — TRIPLE BEAT DISTORTION TEST

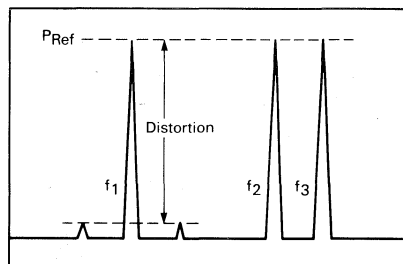
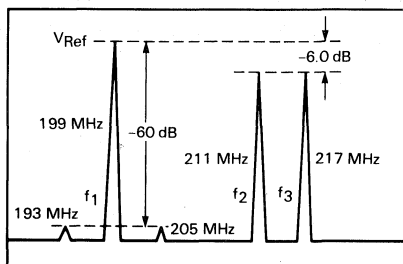


FIGURE 29 — DIN 45004B INTERMODULATION TEST



MRF604

The RF Line

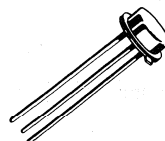
NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt VHF large-signal amplifier applications in industrial equipment with restricted available space.

- Specified 12.5 Volt, 175 MHz Characteristics —
Output Power = 1.0 Watt
Minimum Gain = 10 dB
Efficiency = 50%

1.0 W – 175 MHz
RF POWER
TRANSISTOR
NPN SILICON

2



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	2.0 11.0	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

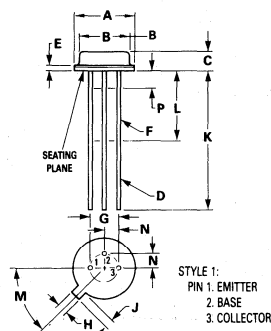
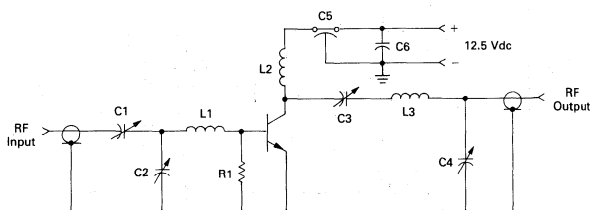


FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C3, C4 — 3.0–30 pF
C5 — 1000 pF
C6 — 0.01 μF
L1 — 2 Turns, #16 AWG, 3/16" I.D., 1/4" Long
L2 — 0.15 μH , MOLDED CHOKE
L3 — 4 Turns, #16 AWG, 3/8" I.D., 3/8" Long
R1 — 100 Ω , 1/4 W, 10%

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	1.65	2.16	0.065	0.085
D	0.406	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.305	0.483	0.012	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 26-03
TO-206AB
(TO-46)

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{Adc}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 12\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	80	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	800	—	—	MHz
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	3.5	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	10	—	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 175\text{ MHz}$)	η	50	—	—	%
Series Equivalent Input Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 175\text{ MHz}$)	Z_{in}	—	$7.5-j\ 14$	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 175\text{ MHz}$)	Z_{out}	—	$47-j\ 60$	—	Ohms

FIGURE 2 — OUTPUT POWER versus INPUT POWER

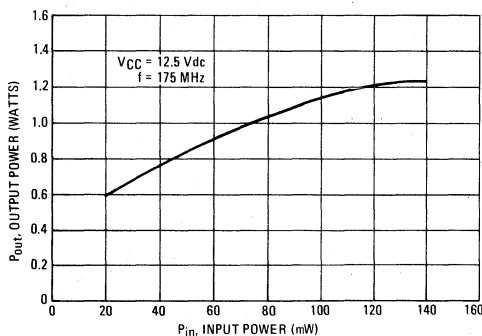


FIGURE 3 — CURRENT-GAIN BANDWIDTH PRODUCT

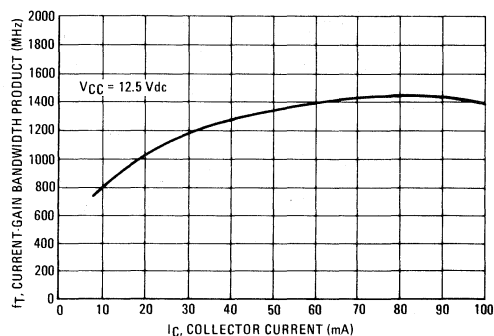
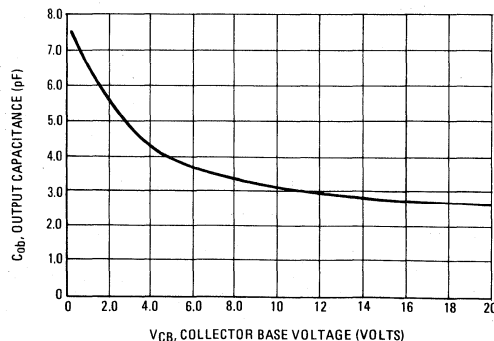


FIGURE 4 — OUTPUT CAPACITANCE versus COLLECTOR BASE VOLTAGE



MRF607

The RF Line

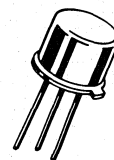
NPN SILICON RF POWER TRANSISTOR

...designed for amplifier, frequency multiplier, or oscillator applications in military, mobile, marine and citizens band equipment. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- Specified 12.5 Volt, 175 MHz Characteristics —
Output Power = 1.75 Watts
Minimum Gain = 11.5 dB
Efficiency = 50%
- Characterized through 225 MHz

1.75 W — 175 MHz

**RF POWER
TRANSISTOR
NPN SILICON**

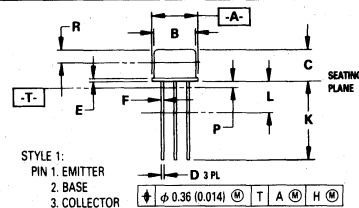
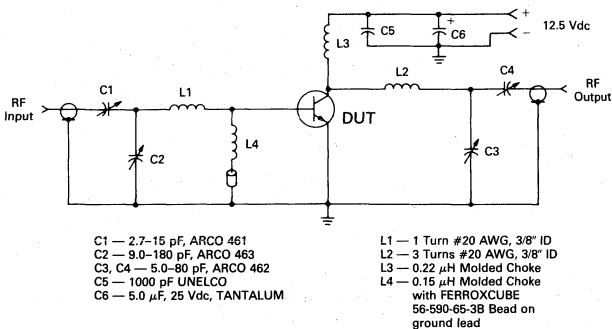


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.33	Adc
Total Device Dissipation @ $T_C = 75^\circ\text{C}$ (1)	P_D	3.5	Watts
Derate above 75°C		28	mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class B or C RF amplifier.

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC



NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.
- DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
- DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
- DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC 0.200 BSC			
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-04
TO-205AD
(TO-39)**

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	Vdc
Collector Cutoff Current ($V_{CE} = 10\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	0.3	mAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 50\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	150	—
DYNAMIC CHARACTERISTICS				
Output Capacitance ($V_{CB} = 12\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	15	pF
FUNCTIONAL TEST (Figure 1)				
Common-Emitter Amplifier Power Gain ($P_{out} = 1.75\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	G_{PE}	11.5	—	dB
Collector Efficiency ($P_{out} = 1.75\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 175\text{ MHz}$)	η	50	—	%

TYPICAL PERFORMANCE DATA

FIGURE 2 — OUTPUT POWER versus FREQUENCY

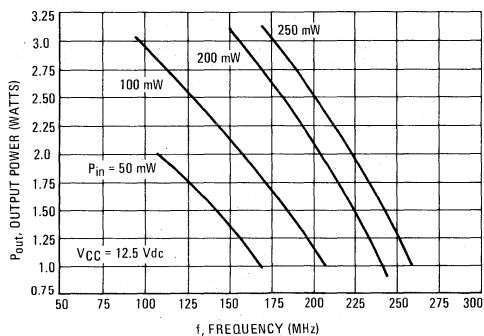


FIGURE 3 — OUTPUT POWER versus INPUT POWER

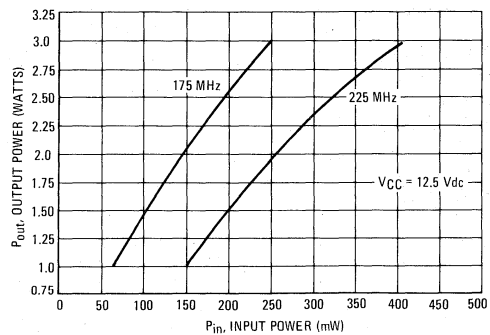


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

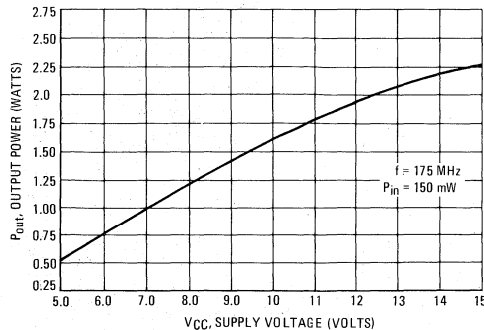
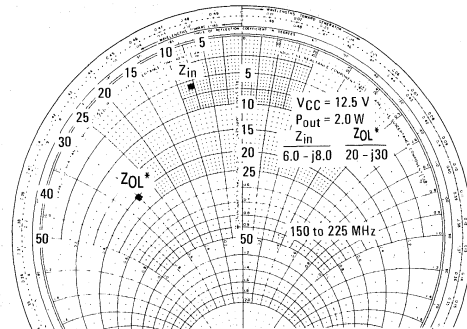


FIGURE 5 — SERIES EQUIVALENT IMPEDANCE PARAMETERS



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MRF627

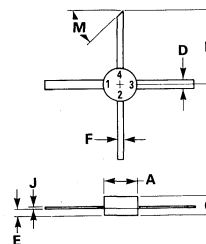
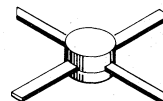
The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for requirements that specify optimum performance in a limited space.

- Specified 12.5 Volt, 470 MHz Characteristics —
 Output Power = 0.5 Watts
 Minimum Gain = 10 dB
 Efficiency = 60%

0.5 W - 470 MHz
HIGH FREQUENCY
TRANSISTOR
 NPN SILICON



STYLE 1:
 PIN 1. EMITTER
 2. BASE
 3. EMITTER
 4. COLLECTOR

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current - Continuous	I_C	150	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate Above 25°C	P_D	2.5 35	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	28.5	$^\circ\text{C/W}$

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.59	0.200	0.220
C	2.41	3.30	0.095	0.130
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	

CASE 305A-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 12\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	—	1.0	mAdc
Emitter Cutoff Current ($V_{BE} = 3.5\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	15	—	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product ($I_C = 50\text{ mAdc}$, $V_{CE} = 12.5\text{ Vdc}$, $f = 200\text{ MHz}$) ($I_C = 100\text{ mAdc}$, $V_{CE} = 12.5\text{ Vdc}$, $f = 200\text{ MHz}$) ($I_C = 150\text{ mAdc}$, $V_{CE} = 12.5\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	— — —	2.5 2.7 2.6	— — —	GHz
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	3.0	3.5	pF
Input Capacitance ($V_{BE} = 1.0\text{ Vdc}$, $I_C = 0$, $f = 1.0\text{ MHz}$)	C_{ib}	—	8.8	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.5\text{ W}$, $f = 470\text{ MHz}$)	G_{PE}	10	12	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.5\text{ W}$, $f = 470\text{ MHz}$)	η	—	60	—	%
Series Equivalent Input Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.5\text{ W}$, $f = 470\text{ MHz}$)	Z_{in}	—	$6.0-j4.0$	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.5\text{ W}$, $f = 470\text{ MHz}$)	Z_{out}	—	$45-j28$	—	Ohms

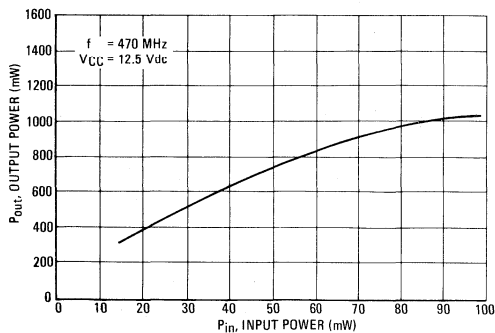
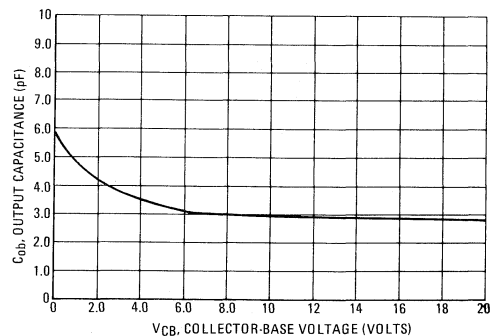
FIGURE 1 – OUTPUT POWER versus INPUT POWER**FIGURE 2 – OUTPUT CAPACITANCE versus COLLECTOR BASE VOLTAGE**

FIGURE 3 — 470 MHz TEST CIRCUIT SCHEMATIC

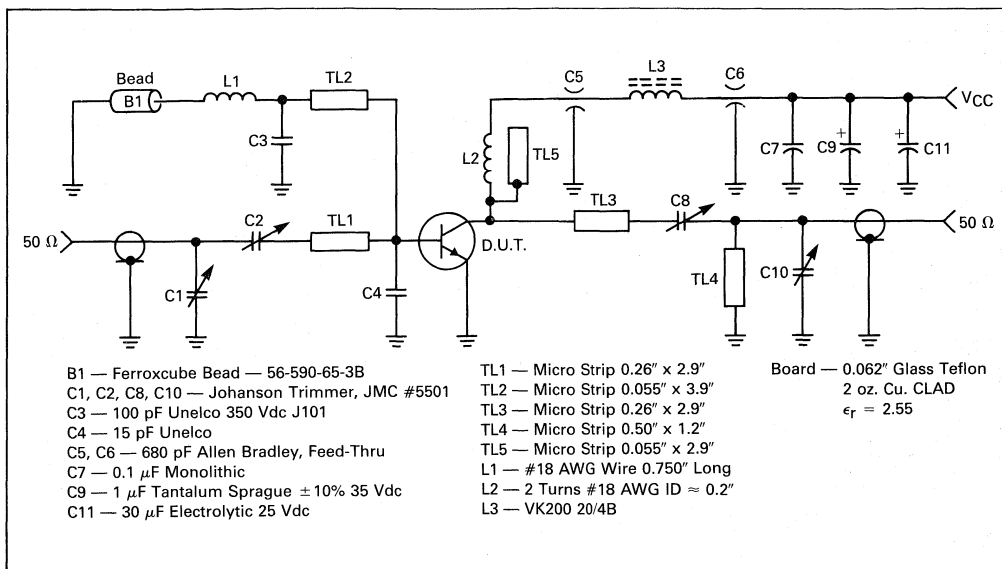


FIGURE 4 — 470 MHz TEST CIRCUIT LAYOUT

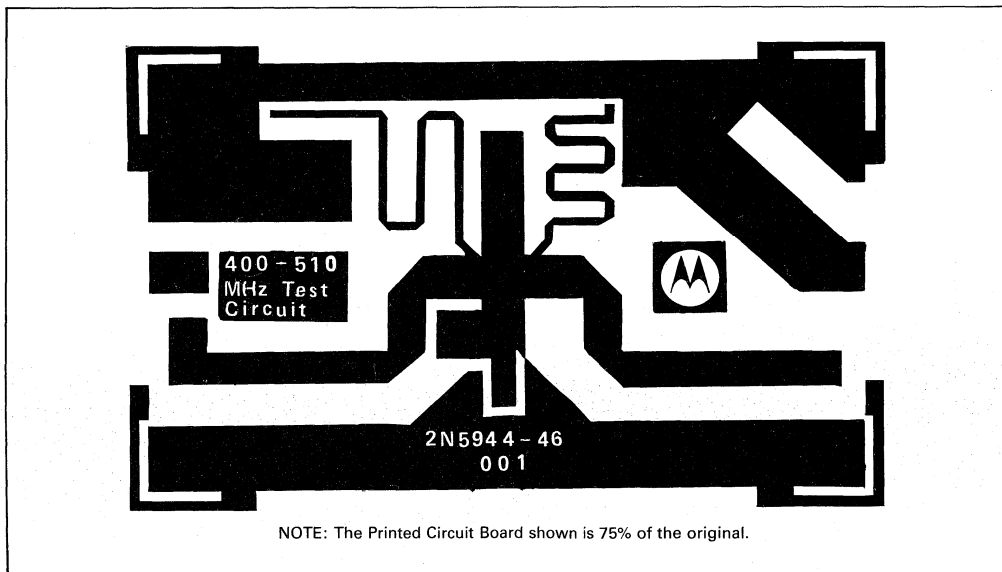
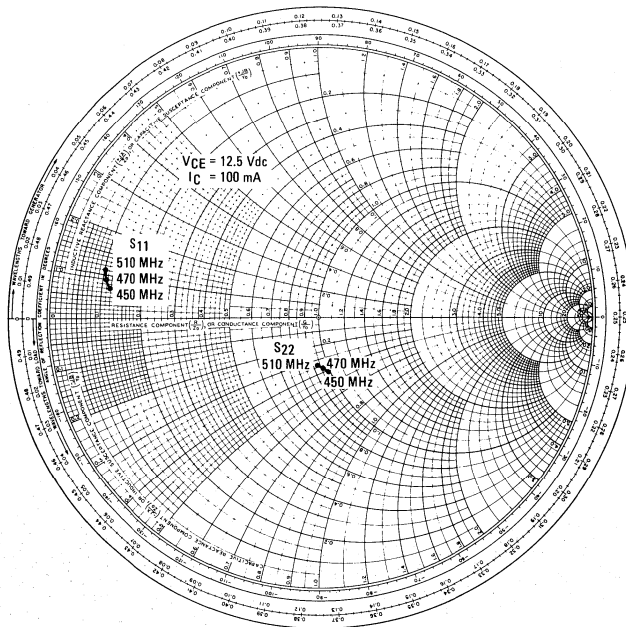
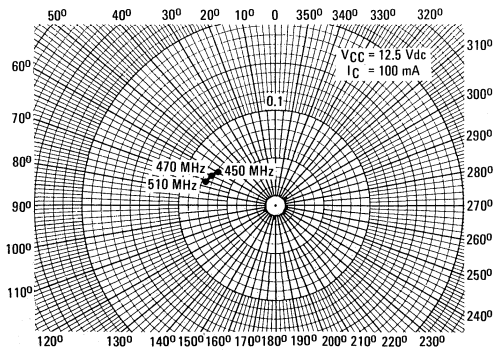
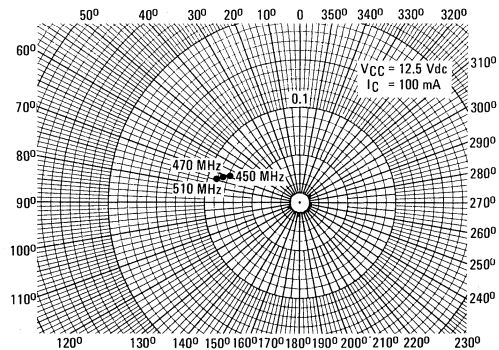


FIGURE 5 – TYPICAL S_{11} and S_{22} versus FREQUENCYFIGURE 6 – TYPICAL S_{12} versus FREQUENCYFIGURE 7 – TYPICAL S_{21} versus FREQUENCY

MRF630

The RF Line

NPN SILICON RF POWER TRANSISTOR

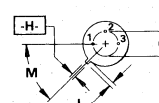
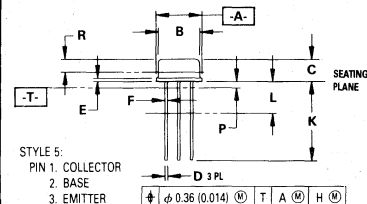
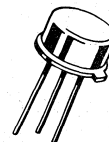
... designed for 12.5 Volt UHF large-signal, amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics
Output Power = 3.0 Watts
Minimum Gain = 9.5 dB
Efficiency = 55%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Grounded Emitter TO-205AD (TO-39) Type Package for High Gain and Excellent Heat Dissipation
- Replaces Medium-Power Stud Mounted Devices
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration

3.0 W 470 MHz

RF POWER TRANSISTOR

NPN SILICON



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
 4. DIMENSION B SHALL NOT VARY MORE THAN 0.025 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
 5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.41	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC 0.200 BSC			
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-05
TO-205AD
(TO-39)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	16	Vdc
Collector-Base Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate Above 25°C	P_D	8.75 50	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 12.5\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	60	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	8.0	12	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Fig. 1) ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 3.0\text{ W}$, $f = 470\text{ MHz}$)	G_{PE}	9.5	10.8	—	dB
Collector Efficiency (Fig. 1) ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 3.0\text{ W}$, $f = 470\text{ MHz}$)	η	—	55	—	%

FIGURE 1 — 470 MHz TEST CIRCUIT SCHEMATIC

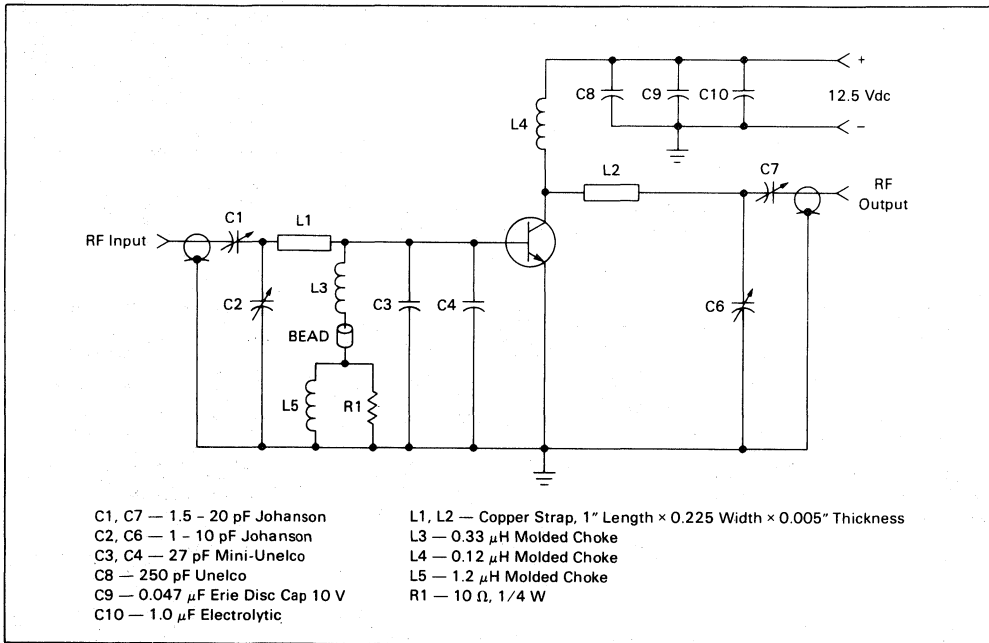


FIGURE 2 — OUTPUT POWER versus INPUT POWER

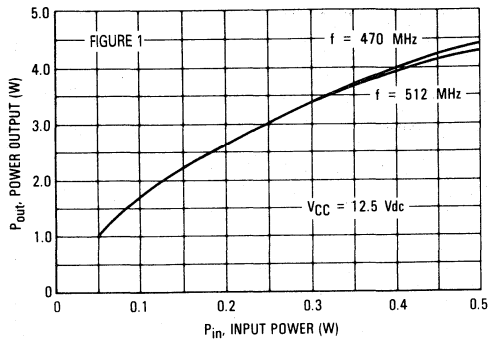


FIGURE 3 — OUTPUT POWER versus FREQUENCY

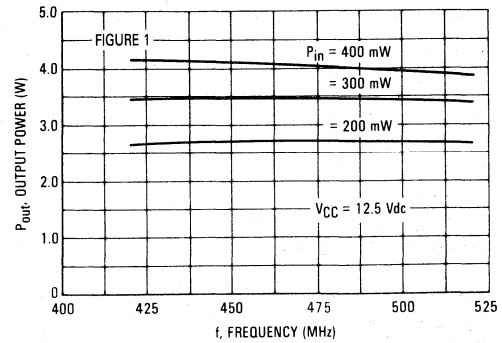


FIGURE 4 — POWER OUT versus SUPPLY VOLTAGE

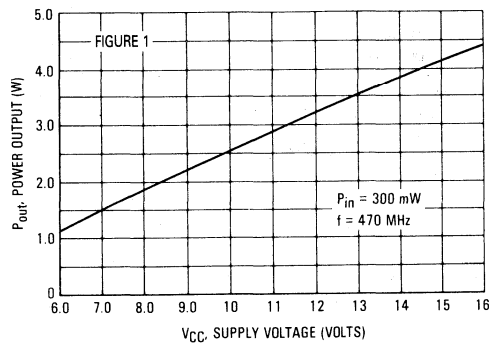
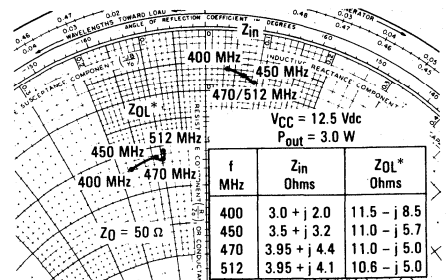


FIGURE 5 — SERIES EQUIVALENT IMPEDANCE



*Z_Q = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

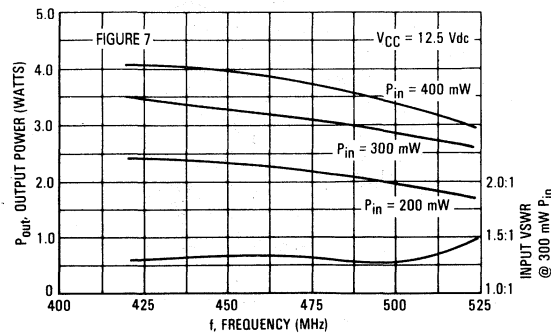
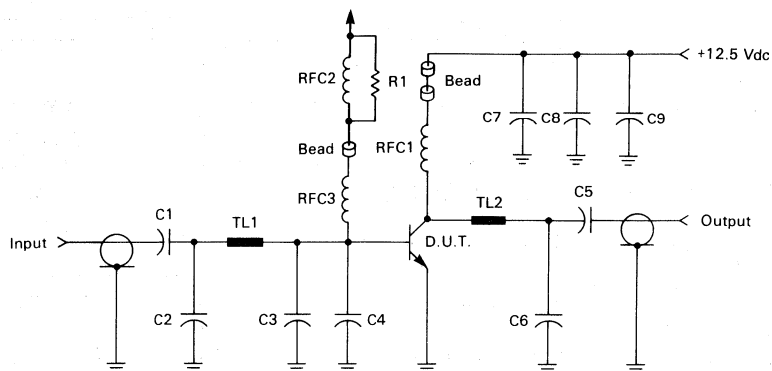
FIGURE 6 — OUTPUT POWER versus FREQUENCY,
BROADBAND CIRCUIT

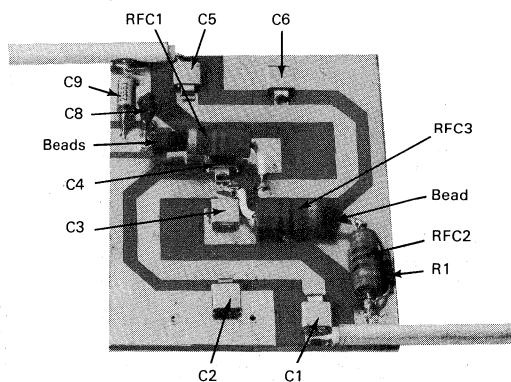
FIGURE 7 — MRF630 BROADBAND CIRCUIT
420-520 MHz



C1, C5 — 43 pF Mini-Unelco
C2 — 10 pF Mini-Unelco
C3 — 18 pF Mini-Unelco
C4 — 27 pF Mini-Unelco
C6 — 6.8 pF Mini-Unelco
C7 — 220 pF Ceramic Chip
C8 — 0.1 mF
C9 — 1.0 mF Tantalum

RFC1 — 0.47 μ H Molded Choke
RFC2 — 1.0 μ H Molded Choke
RFC3 — 0.3 μ H Molded Choke
R1 — 12 Ω /1/4 W
TL1 — Transmission Line 0.166" \times 1.85" (WXL)
TL2 — Transmission Line 0.166" \times 1.77" (WXL)
Board Material — 2 oz. 0.0625" TFG

FIGURE 8 — BROADBAND CIRCUIT



MRF641

The RF Line

NPN SILICON RF POWER TRANSISTOR

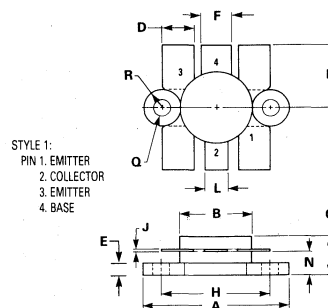
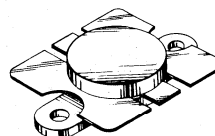
... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics —
Output Power = 15 Watts
Minimum Gain = 7.8 dB
Efficiency = 55%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16-Volt High Line and Overdrive.

15 W — 470 MHz

CONTROLLED Q

**RF POWER
TRANSISTOR
NPN SILICON**



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

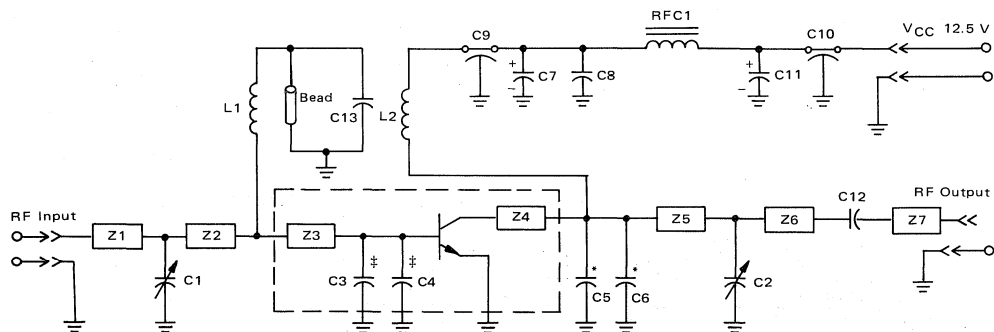
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	16	V _{dc}
Collector-Base Voltage	V _{CBO}	36	V _{dc}
Emitter-Base Voltage	V _{EBO}	4.0	V _{dc}
Collector Current — Continuous	I _C	3.0	A _{dc}
Total Device Dissipation @ T _C = 25°C Derate above 25°C	P _D	50 0.25	Watts W/°C
Storage Temperature Range	T _{stg}	—65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	R _{θJC}	4.0	°C/W
--------------------------------------	------------------	-----	------

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	5.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	30	70	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	40	60	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 470\text{ MHz}$)	G_{pe}	7.8	8.5	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 470\text{ MHz}$)	η	55	60	—	%
Output Mismatch Stress ($V_{CC} = 16\text{ Vdc}$, $P_{in} = 3.0\text{ W}$, $f = 470\text{ MHz}$, $VSWR = 20:1$, All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 – TEST CIRCUIT SCHEMATIC**PARTS**

Z1 = 1.225" X 0.187" Microstrip
 Z2 = 0.884" X 0.187" Microstrip
 Z3 = Capacitor Block (Base)
 Z4 = Collector Block
 Z5 = 1.1" X 0.187" Microstrip
 Z6 = 0.433" X 0.187" Microstrip
 Z7 = 0.4" X 0.187" Microstrip

Dotted Area – Capacitor Assembly

C1, C2 – 0.8–10 pF Johanson
 C3, C4 – 24 pF Chip Caps 100 mils ATC
 C5, C6 – 22 pF Chip Caps 100 mils ATC
 C12 – 220 pF Chip Cap 100 mils ATC
 C7, C11 – 1.0 μF Tantalum 35 Vdc
 C9, C10 – 680 pF Feedthrough Allen-Bradley
 C13 – 200 pF UNELCO
 C8 – 0.1 μF , 50 V Erie Red Cap
 RFC1 – VK 200 – 104B Ferrite Choke
 L1 – 4 Turns 0.2" Dia. #16 AWG
 L2 – 9 Turns 0.15" Dia. #16 AWG
 Bead – Ferroxcube 56-590-65-35EB

NOTES

**C5, C6, are mounted as close to the capacitor assembly as possible.

‡‡C3, C4 are mounted in the capacitor assembly.
 Board – 62.5 mil Glass Teflon, $\epsilon_R = 2.55$.

FIGURE 2 – POWER OUTPUT versus POWER INPUT

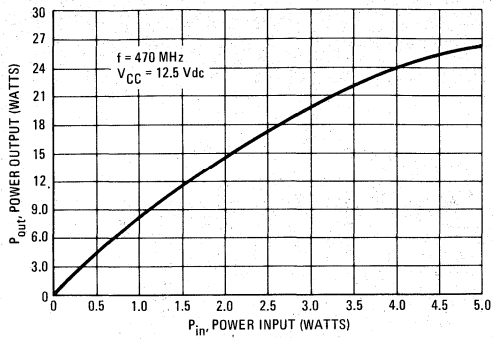


FIGURE 3 – POWER OUTPUT versus FREQUENCY

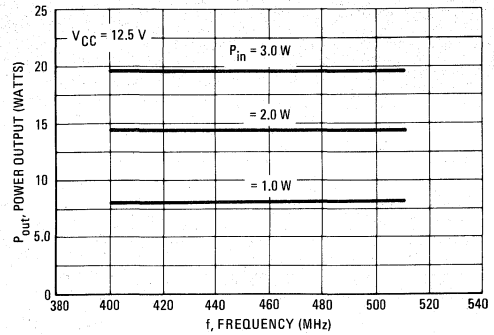


FIGURE 4 – POWER OUTPUT versus SUPPLY VOLTAGE

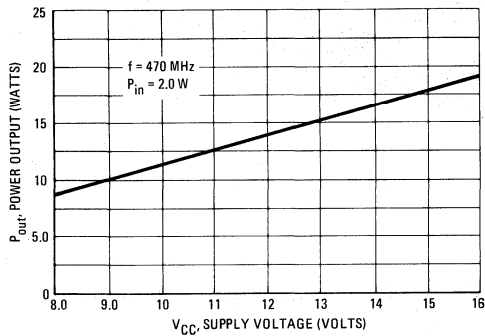


FIGURE 5 – POWER SATURATION PROFILE

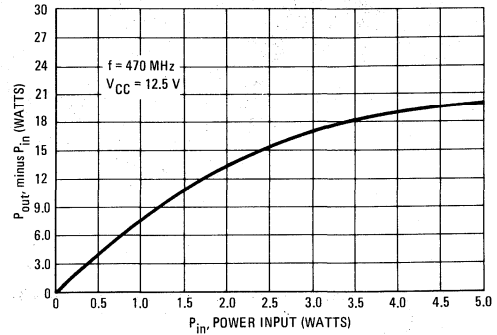
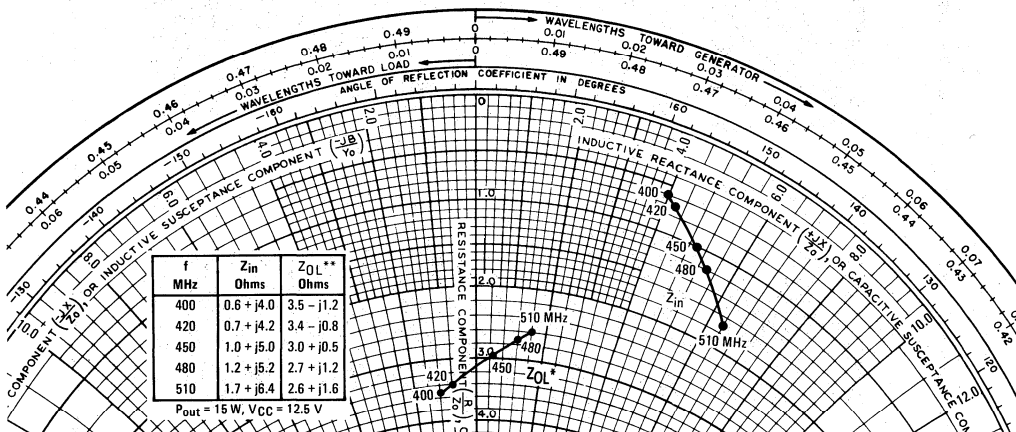
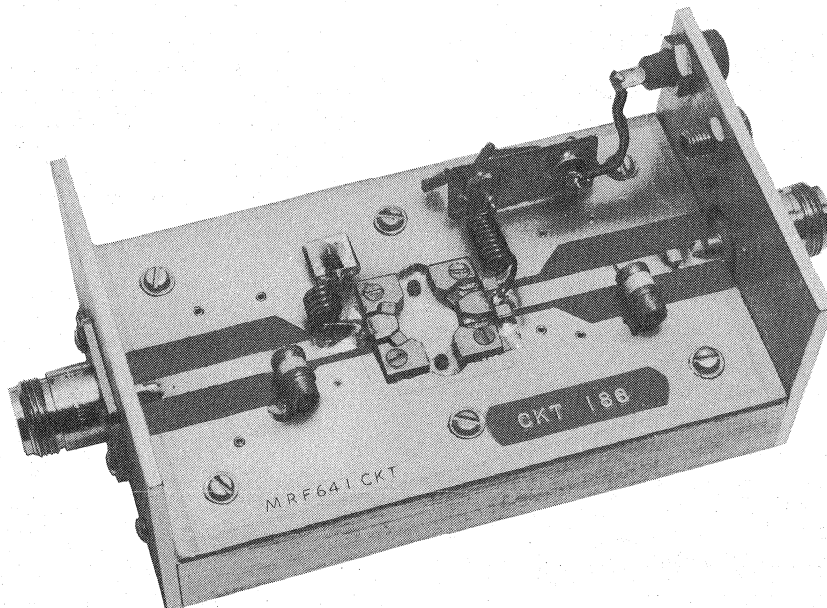


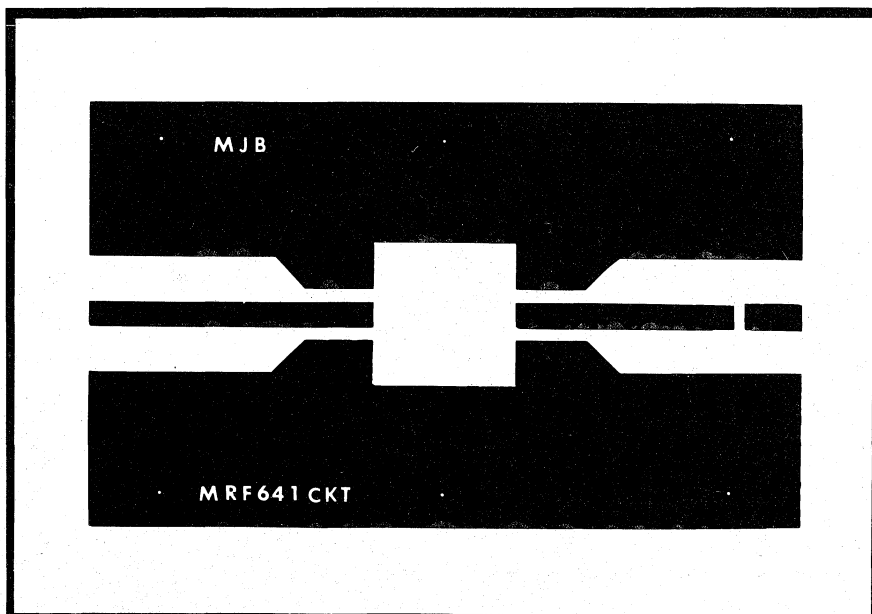
FIGURE 6 – SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



** Z_{OL} = Conjugate of the load impedance into which the device output operates at a given power, η , and frequency.



MRF641 TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF644

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics —
Output Power = 25 Watts
Minimum Gain = 6.2 dB
Efficiency = 60%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16-Volt High Line and 50% Overdrive.

MAXIMUM RATINGS

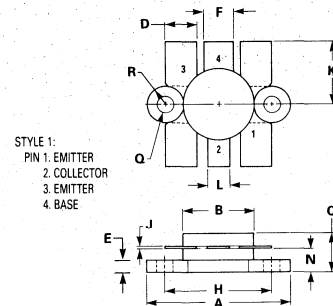
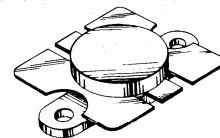
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	103 0.59	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.7	$^\circ\text{C/W}$
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25 W — 470 MHz

CONTROLLED Q
RF POWER
TRANSISTOR
NPN SILICON



NOTE:
FLANGE IS ISOLATED IN ALL STYLES

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

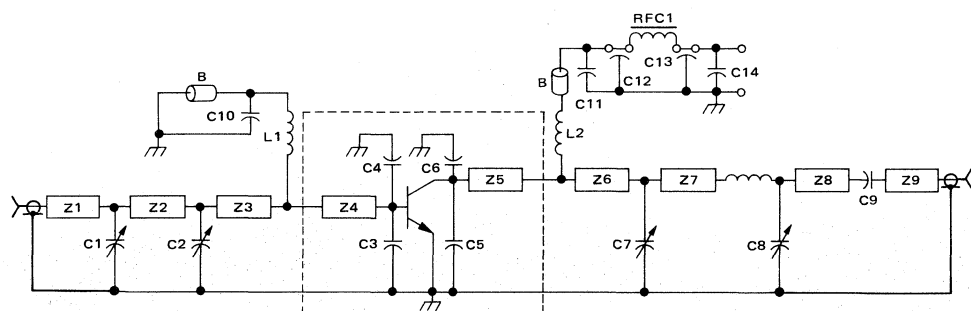
ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	5.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 4.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	40	70	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	60	85	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 25\text{ W}$, $I_C (\text{MAX}) = 3.6\text{ A}$, $f = 470\text{ MHz}$)	G_{pe}	6.2	7.0	—	dB
Input Power ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 25\text{ W}$, $f = 470\text{ MHz}$)	P_{in}	—	5.0	6.0	Watts
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 25\text{ W}$, $I_C (\text{MAX}) = 3.6\text{ A}$, $f = 470\text{ MHz}$)	η	55	60	—	%
Output Mismatch Stress ($V_{CC} = 16\text{ Vdc}$, $P_{in} = \text{Note 1}$, $f = 470\text{ MHz}$, $VSWR = 20:1$, All Phase Angles)	ψ^*	No Degradation in Output Power			
Series Equivalent Input Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 25\text{ W}$, $f = 470\text{ MHz}$)	Z_{in}	—	$1.2 + j3.3$	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 25\text{ W}$, $f = 470\text{ MHz}$)	Z_{OL}	—	$1.9 + j2.1$	—	Ohms

Notes:

1. $P_{in} = 150\%$ of Drive Requirement for 25 W Output at 12.5 Vdc.* ψ = Mismatch stress factor—the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.

FIGURE 1 — TEST CIRCUIT SCHEMATIC



C1, C2, C7, C8 1–20 pF JOHANSON Variable
 C3 27 pF 100 mil ATC
 C4 30 pF 100 mil ATC
 C5, C6 33 pF 100 mil ATC
 C9 250 pF 100 mil ATC
 C10 100 pF UNELCO
 C11, C14 1 μF 35 V TANTALUM

C12, C13 680 pF Feedthrough
 L1 5" #22 AWG 0.100" ID
 L2 5" #20 AWG 0.187" ID
 RFC1 Ferroxcube VK200-20-4B
 B Ferroxcube Bead 56-590-65-3B
 Z1 0.25" x 0.20" Microstrip
 Z2 1.63" x 0.20" Microstrip

Z3 0.20" x 0.20" Microstrip
 Z4, Z5 1/2" #18 AWG bent in a "V" shape 1/8" Wide
 Z6 0.20" x 0.20" Microstrip
 Z7 0.70" x 0.20" Microstrip
 Z8 0.33" x 0.20" Microstrip
 Z9 0.50" x 0.20" Microstrip
 Board 62.5 mil Glass Teflon, $\epsilon_R = 2.55$

FIGURE 2 – POWER OUTPUT versus POWER INPUT

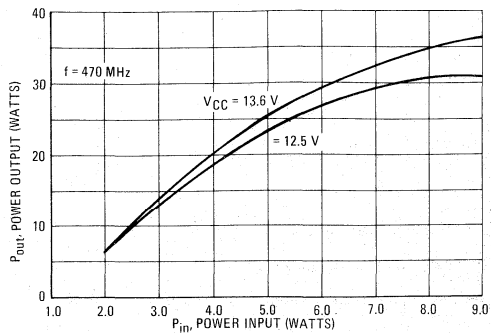


FIGURE 3 – POWER OUTPUT versus FREQUENCY

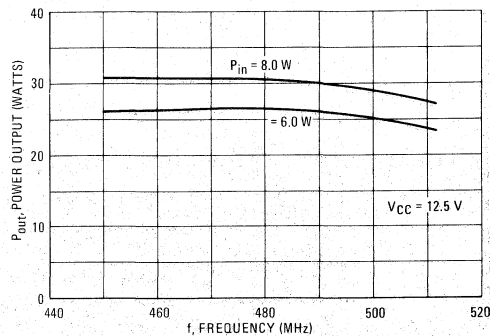


FIGURE 4 – POWER OUTPUT versus SUPPLY VOLTAGE

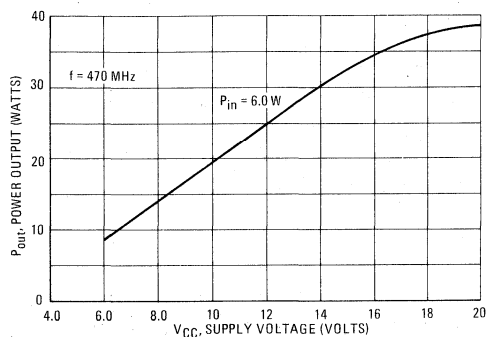


FIGURE 5 – POWER SATURATION PROFILE

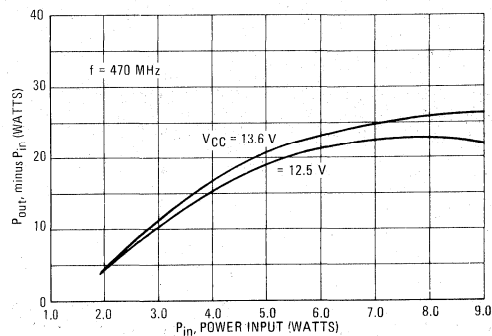
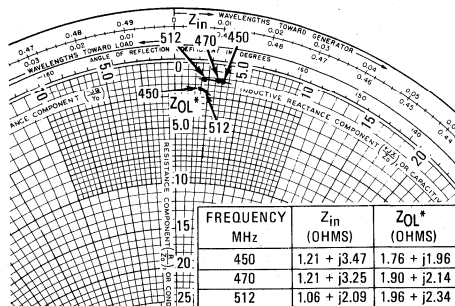


FIGURE 7 – SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

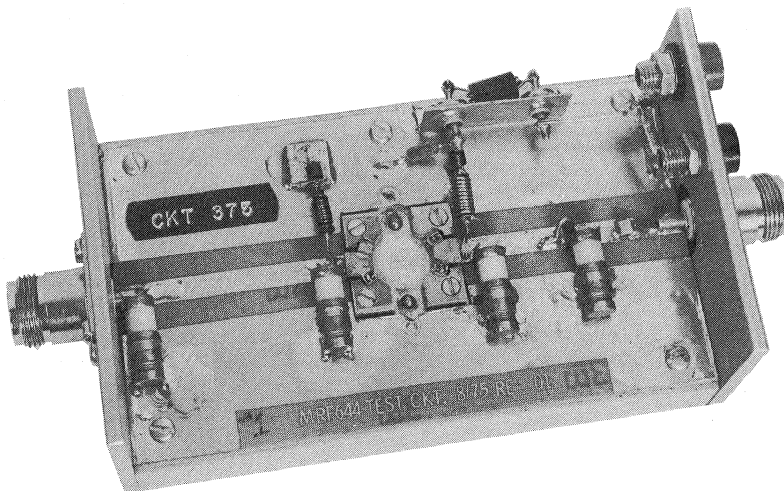
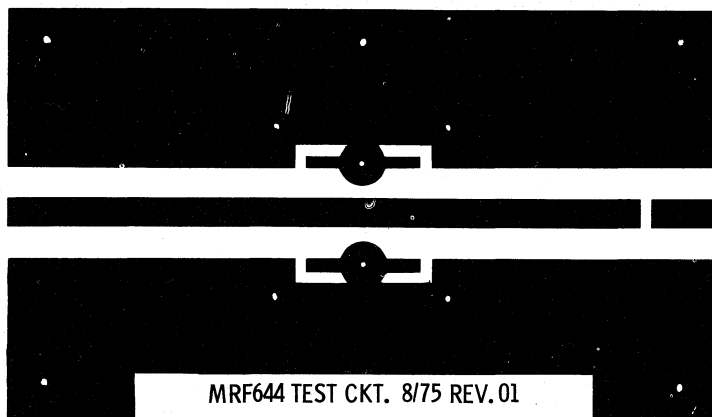


FIGURE 8 — MRF644 TEST FIXTURE



MRF644 TEST CKT. 8/75 REV. 01

NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 9 — PRINTED CIRCUIT BOARD

MRF646

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics —
Output Power = 45 Watts
Minimum Gain = 4.8 dB
Efficiency = 55%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with
20:1 VSWR @ 16-Volt High Line and 50% Overdrive.

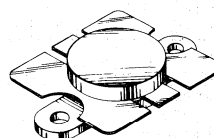
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	9.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	117 0.67	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

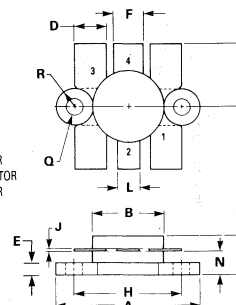
THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	$^\circ\text{C/W}$
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45 W — 470 MHz
CONTROLLED Q
RF POWER
TRANSISTOR
NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE



NOTE:
FLANGE IS ISOLATED IN ALL STYLES

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

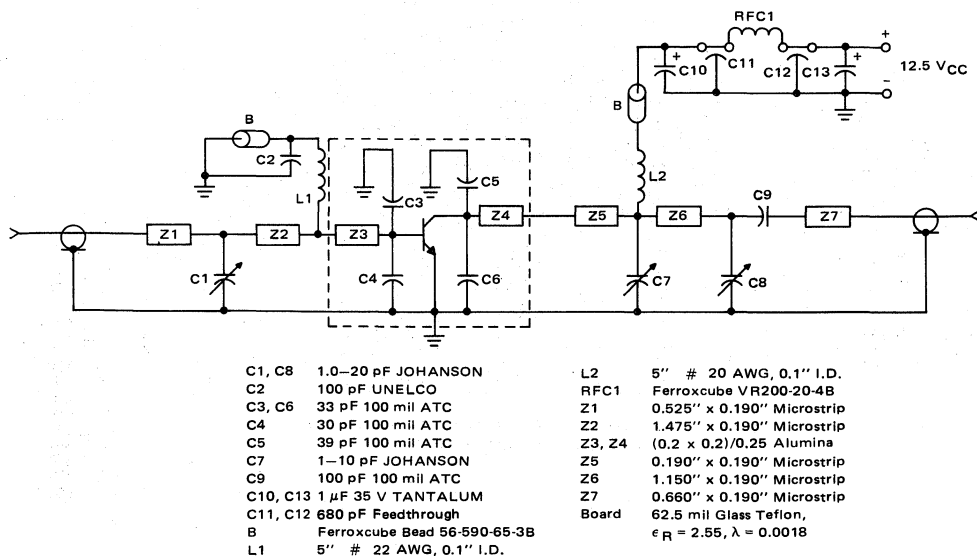
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	10	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 4.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	70	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	90	125	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 45\text{ W}$, $I_C(\text{Max}) = 5.8\text{ A}$, $f = 470\text{ MHz}$)	G_{pe}	4.8	5.4	—	dB
Input Power ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 45\text{ W}$, $f = 470\text{ MHz}$)	P_{in}	—	13	15	Watts
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 45\text{ W}$, $I_C(\text{Max}) = 5.8\text{ A}$, $f = 470\text{ MHz}$)	η	55	60	—	%
Load Mismatch Stress ($V_{CC} = 16\text{ Vdc}$, $P_{in} = \text{Note 1}$, $f = 470\text{ MHz}$, $V_{SWR} = 20:1$, All Phase Angles)	ψ^*	No Degradation in Output Power			
Series Equivalent Input Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 45\text{ W}$, $f = 470\text{ MHz}$)	Z_{in}	—	$1.4 + j4.0$	—	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 45\text{ W}$, $f = 470\text{ MHz}$)	Z_{OL}^*	—	$1.2 + j2.8$	—	Ohms

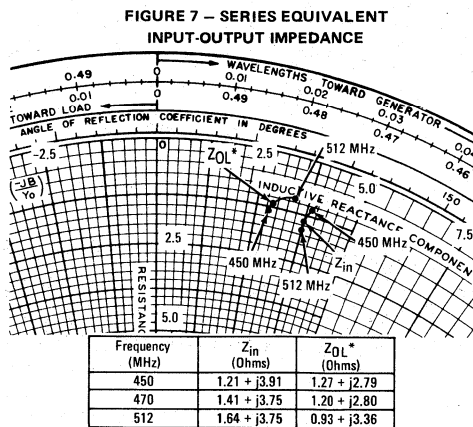
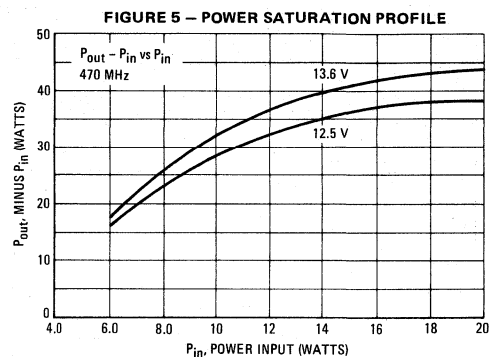
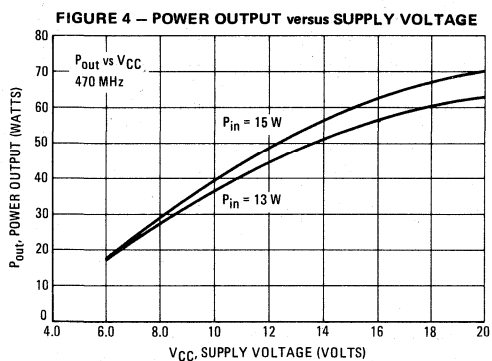
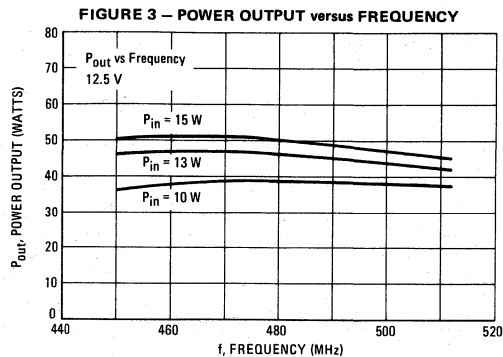
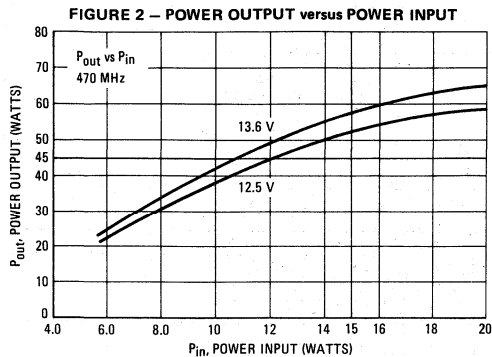
Notes:

1. $P_{in} = 150\%$ of Drive Requirement for 45 W output @ 12.5 V.

* ψ = Mismatch stress factor—the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.

FIGURE 1 – TEST CIRCUIT SCHEMATIC





* Z_{L} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

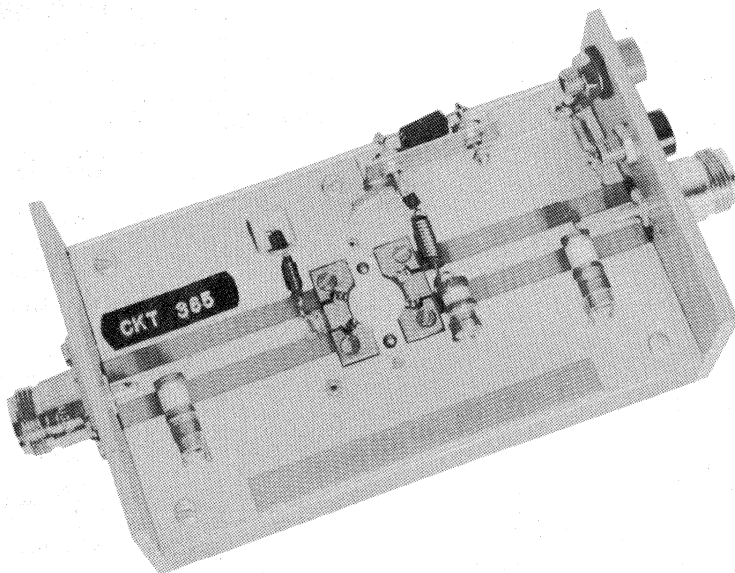
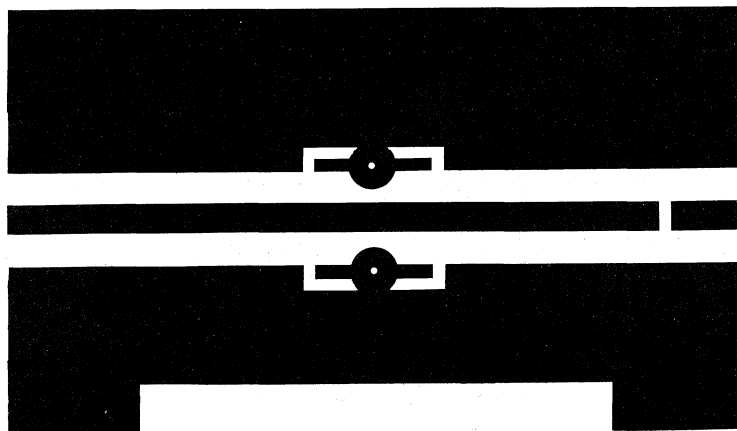


FIGURE 8 — MRF644 TEST FIXTURE



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 9 — PRINTED CIRCUIT BOARD

MRF648

The RF Line

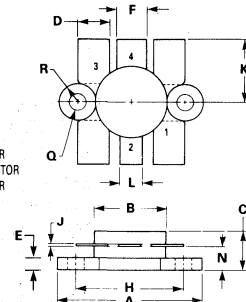
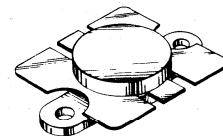
NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics --
Output Power = 60 Watts
Minimum Gain = 4.4 dB
Efficiency = 55%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16-Volt High Line and 20% Overdrive

60 W — 470 MHz

**CONTROLLED Q
RF POWER
TRANSISTOR
NPN SILICON**



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	11.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	175 1.0	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	$^\circ\text{C/W}$
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ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	15	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 6.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	70	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	130	150	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 60\text{ W}$, $f = 470\text{ MHz}$)	G_{pe}	4.4	5.0	—	dB
Input Power ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 60\text{ W}$, $f = 470\text{ MHz}$)	P_{in}	—	19	22	Watts
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 60\text{ W}$, $f = 470\text{ MHz}$)	η	55	65	—	%
Output Mismatch Stress ($V_{CC} = 16\text{ Vdc}$, $P_{in} = 26\text{ W}$, $f = 470\text{ MHz}$, $VSWR = 20:1$, All Phase Angles)	ψ^*	No Degradation in Output Power			

Notes:

- * ψ = Mismatch stress factor—the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.

FIGURE 1 — TEST CIRCUIT SCHEMATIC

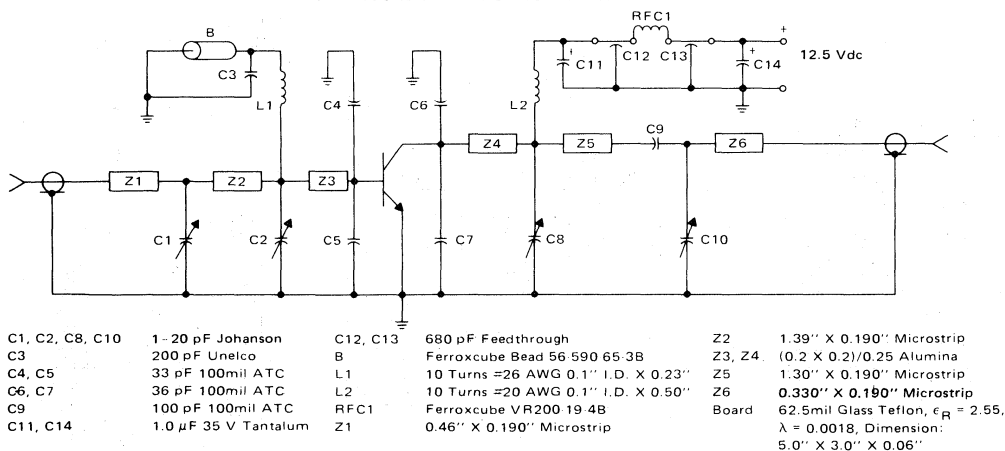


FIGURE 2 — POWER OUTPUT versus POWER INPUT

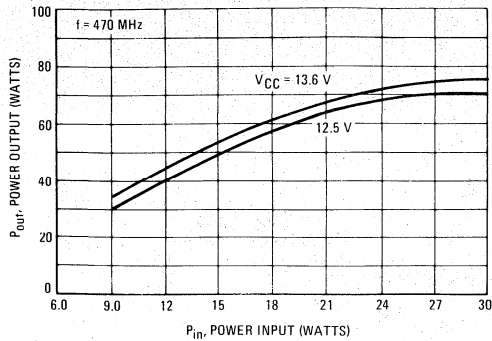


FIGURE 3 — POWER OUTPUT versus FREQUENCY

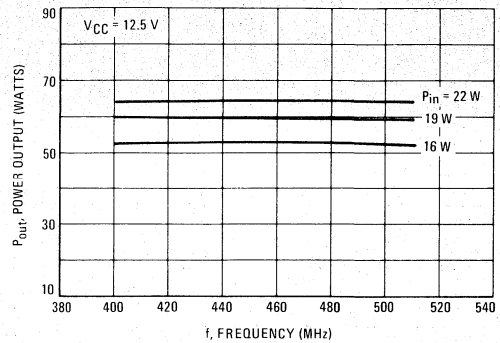


FIGURE 4 — POWER OUTPUT versus SUPPLY VOLTAGE

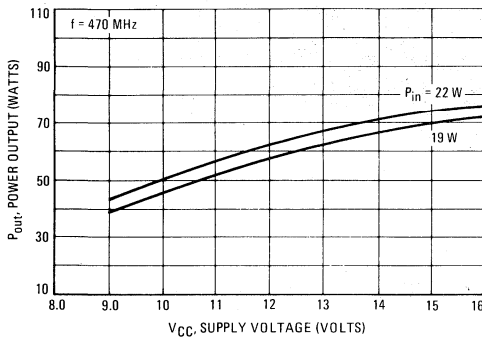


FIGURE 5 — POWER SATURATION PROFILE

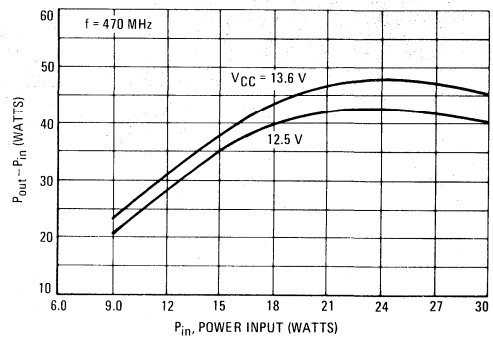
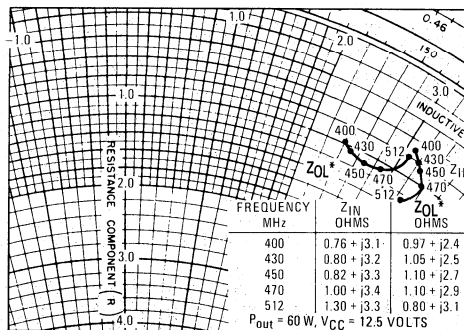
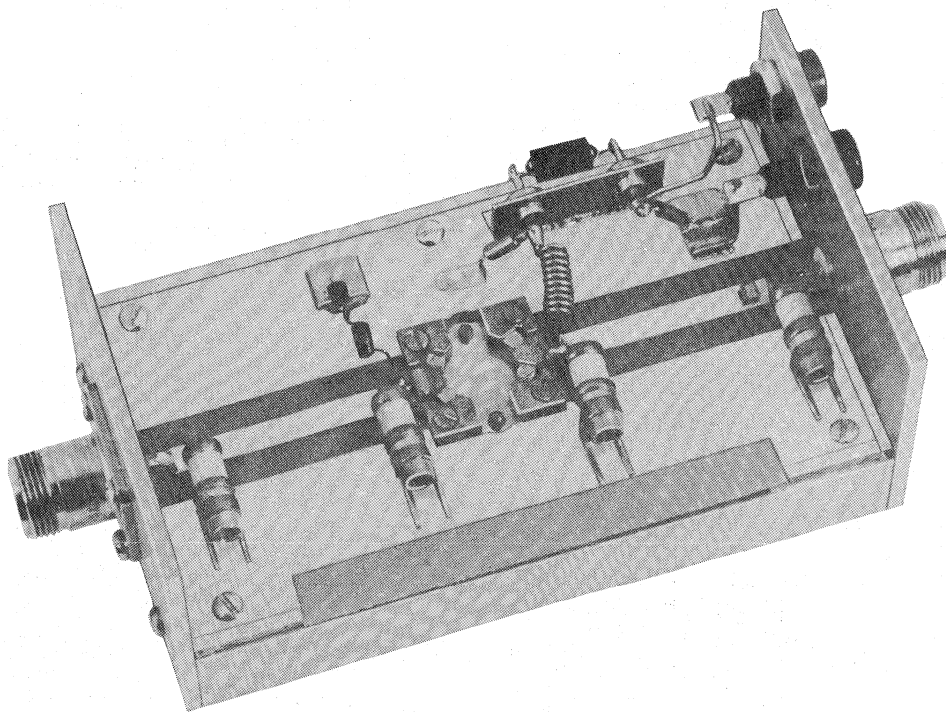


FIGURE 6 — SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE

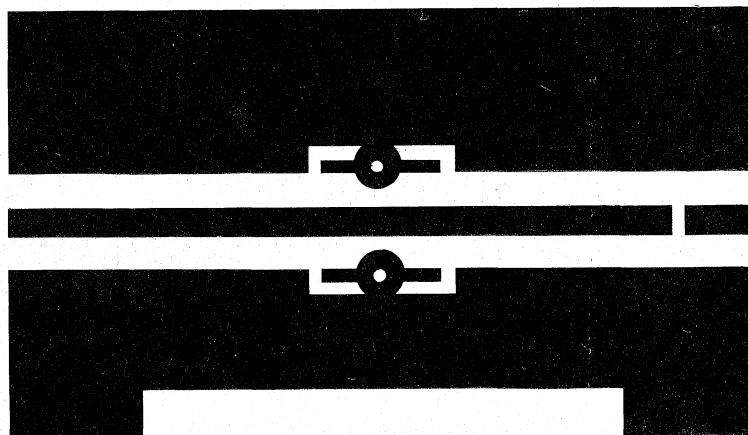


*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2



TEST CIRCUIT TEST FIXTURE



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF652

The RF Line

NPN SILICON RF POWER TRANSISTOR

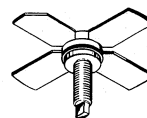
... designed for 12.5 Vdc UHF large-signal, amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Guaranteed 12.5 Volt, 512 MHz Characteristics
Output Power = 5.0 Watts
Minimum Gain = 10 dB
Efficiency = 65% (Typ)
- Typical Performance at 870 MHz, 12.5 V, 5.0 W Output = 6.0 dB
- Series Equivalent Large-Signal Characterization
- Gold Metallized, Emitter Ballasted for Long Life and Reliability
- Capable of 30:1 VSWR Load Mismatch at 15.5 V Supply Voltage

5.0 W 512 MHz

RF POWER TRANSISTOR

NPN SILICON

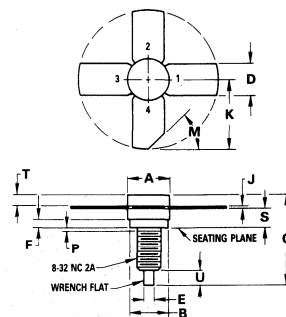


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate Above 25°C	P_D	25 143	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7.0	$^\circ\text{C}/\text{W}$



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

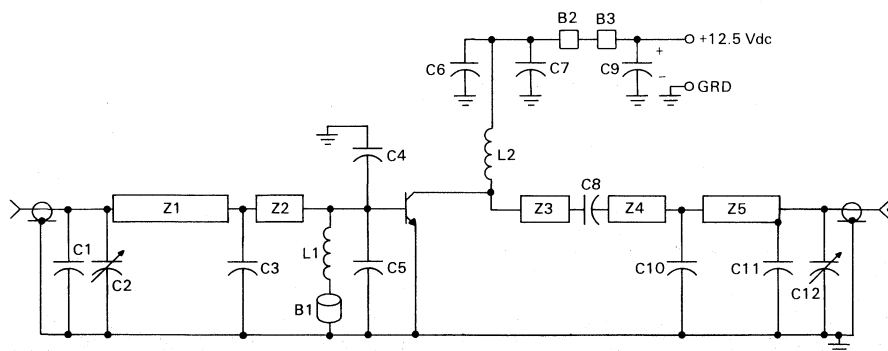
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	9.5	15	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 5.0\text{ W}$)	$f = 512\text{ MHz}$ $f = 870\text{ MHz}$ G_{pe}	10 —	11 6.0	— —	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 512\text{ MHz}$)	η	—	65	—	%
Load Mismatch ($V_{CC} = 15.5\text{ Vdc}$, $P_{out} = 6.0\text{ W}$, $f = 512\text{ MHz}$, VSWR 30:1 At All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 440-512 MHz BROADBAND TEST CIRCUIT



B1-B3 — Ferrite Bead
 C1 — 7.0 pF Unelco Mica
 C2 — 1.0-6.0 pF Johanson Variable 5201
 C3 — 15 pF Unelco Mica
 C4 — 43 pF Mini-Underwood Mica
 C5 — 56 pF Mini-Underwood Mica
 C6 — 1000 pF Unelco Mica
 C7 — 0.1 μF Ceramic

C8 — 68 pF Mini-Underwood Mica
 C9 — 1.0 μF Electrolytic 25 V
 C10, C11 — 5.0 pF Unelco Mica
 C12 — 1.0-10 pF Johanson Variable 5501
 L1, L2 — 6 Turns, 20 AWG Wire 0.125" ID
 Z1, Z2 — 25 Ohm $\mu\text{Stripline}$ (See Photo-Mask - Figure 7)
 Z3-Z5 — 50 Ohm $\mu\text{Stripline}$ (See Photo-Mask - Figure 7)
 Board — 0.032" Glass-Teflon

FIGURE 2 — OUTPUT POWER versus INPUT POWER

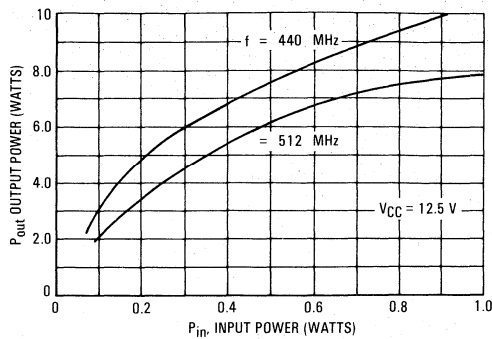


FIGURE 3 — OUTPUT POWER versus FREQUENCY

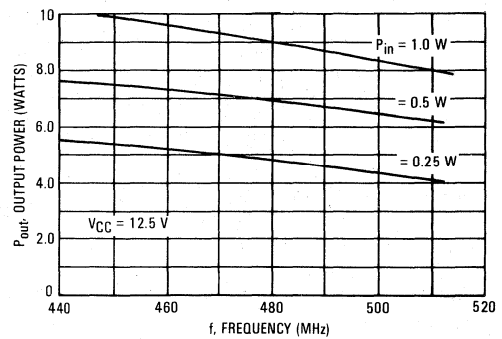


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

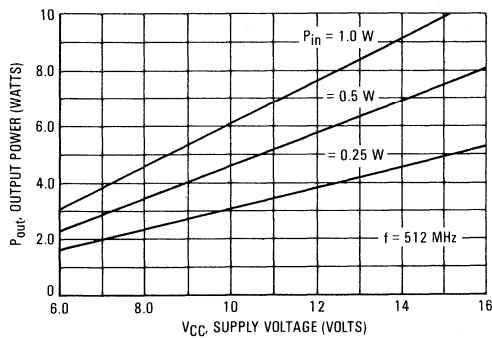


FIGURE 5 — TYPICAL BROADBAND CIRCUIT PERFORMANCE

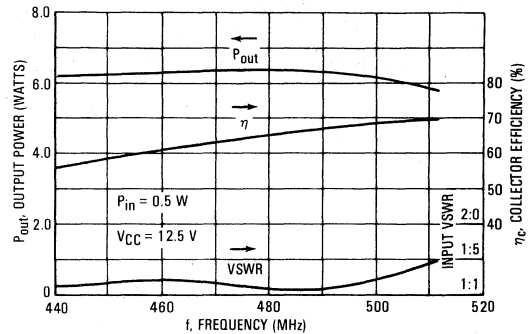
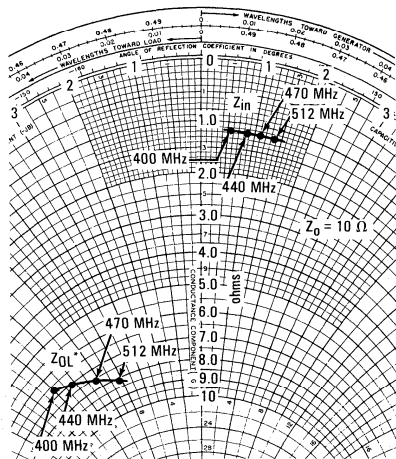


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

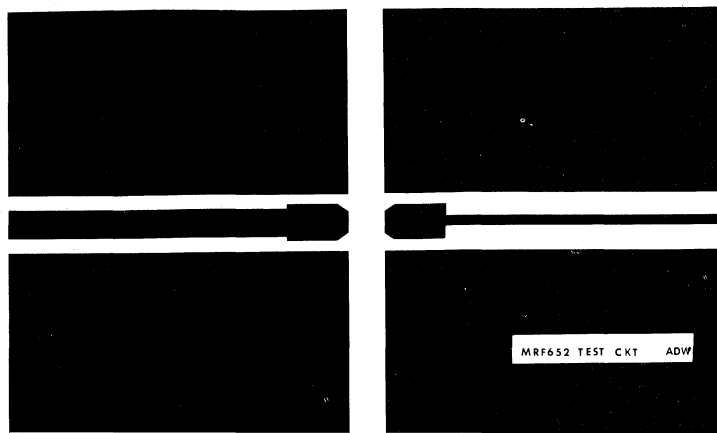


$V_{CC} = 12.5 \text{ Vdc}$
 $P_{out} = 5.0 \text{ W}$

f MHz	Z_{in} Ohms	Z_{out}^* Ohms
400	$1.18 + j0.54$	$6.7 - j6.9$
440	$1.19 + j0.88$	$7.05 - j6.1$
470	$1.19 + j1.11$	$7.6 - j5.1$
512	$1.19 + j1.35$	$8.1 - j4.1$

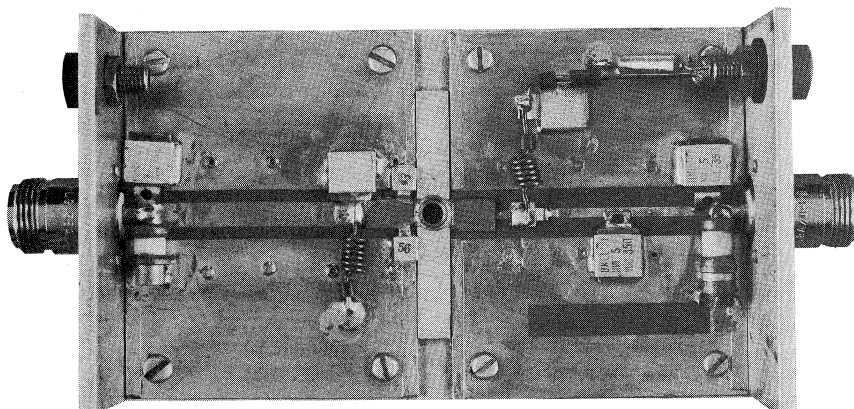
* Z_{out} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 — PHOTOMASTER BROADBAND TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 8 — BROADBAND TEST CIRCUIT



The RF Line
NPN Silicon
RF Power Transistor

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 512 MHz Characteristics
Output Power = 10 W
Gain = 8 dB (Typ)
Efficiency = 65% (Typ)
- Gold Metallized, Emitter Ballasted for Long Life and Reliability
- Capable of 20:1 VSWR Load Mismatch at 16 V Supply Voltage

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Base Voltage	V_{CBO}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	2.75	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	44 0.25	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	38	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ Adc}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	20	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	22	28	pF
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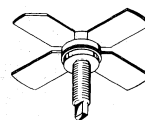
FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 10\text{ W}$, $f = 512\text{ MHz}$)	G_{pe}	7	8	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 10\text{ W}$, $f = 512\text{ MHz}$)	η_c	55	65	—	%
Load Mismatch Stress ($V_{CC} = 16\text{ Vdc}$, $f = 512\text{ MHz}$, $P_{in}^* = 2.6\text{ W}$, VSWR = 20:1 All Phase Angles)	ψ	No Degradation in Output Power			

* $P_{in} = 2\text{ dB}$ over the typical input power required for 10 W output power @ 12.5 Vdc

MRF653

10 W 512 MHz
RF POWER
TRANSISTOR
NPN SILICON



CASE 244-04
CERAMIC

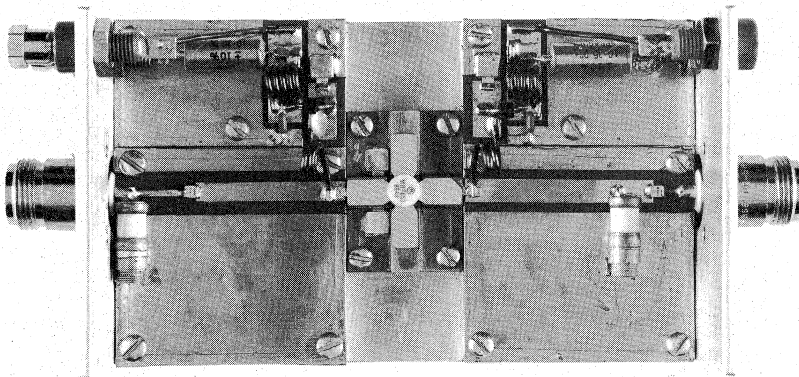
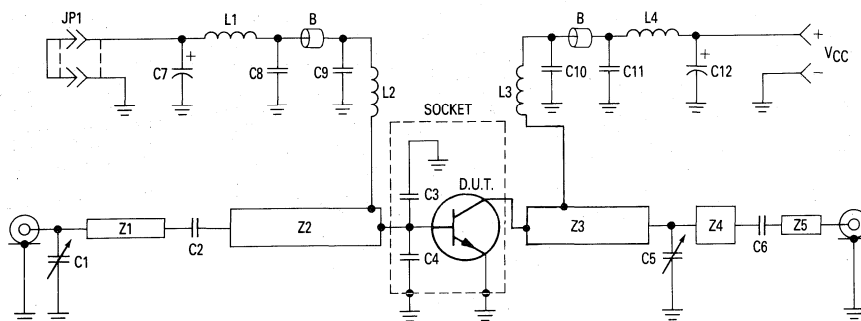


Figure 1. Broadband Test Circuit



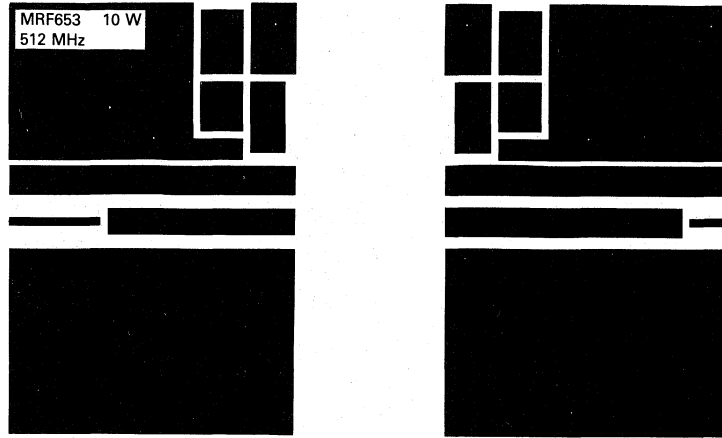
C1, C5 — 1–20 pF, Johanson
 C2, C6 — 330 pF, 100 Mil ATC
 C3, C4 — 36 pF, Mini-Unelco
 C7, C12 — 10 μ F, 35 V, Tantalum
 C8, C11 — 0.1 μ F, Ceramic
 C9, C10 — 91 pF, Mini-Unelco

L1, L4 — 4-1/2 Turns, #18 AWG, 0.16" ID
 L2, L3 — 2 Turns, #18 AWG, 0.16" ID
 B — Ferrite Bead, Ferroxcube 56-590-65-3B
 Z1 — 51 x 630 mils
 Z2 — 162 x 1300 mils
 Z3 — 210 x 1350 mils
 Z4 — 210 x 280 mils
 Z5 — 51 x 300 mils

Board Material — 0.032" epoxy glass G10, 1 oz., copper clad,
 double sided, $\epsilon_r = 5$

JP1 — Jumper, #14 AWG w/Banana Plugs

Figure 2. Broadband Test Circuit Schematic



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 3. Photomaster

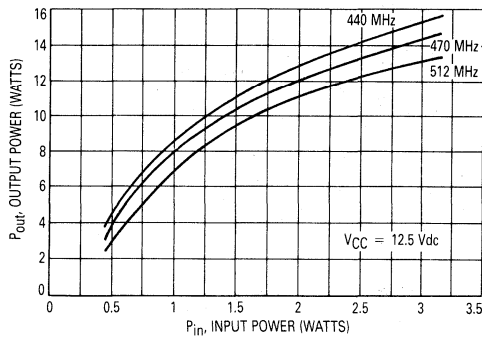


Figure 4. Output Power versus Input Power

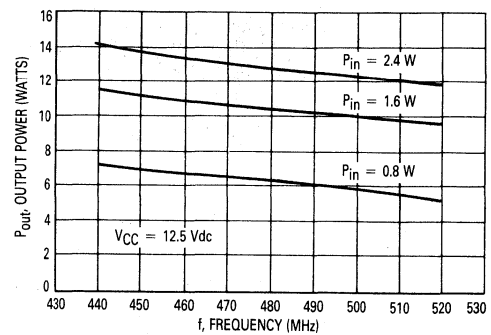


Figure 5. Output Power versus Frequency

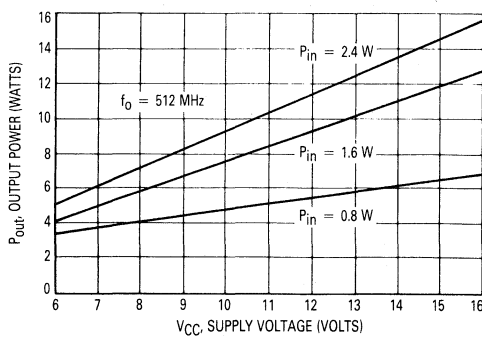


Figure 6. Output Power versus Supply Voltage

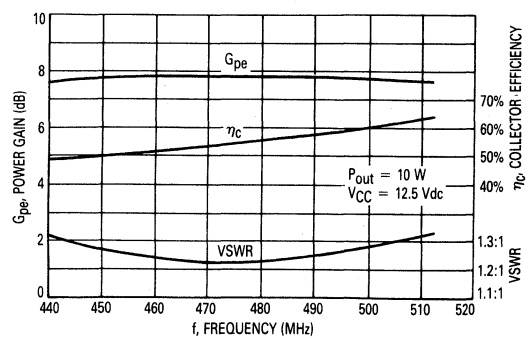


Figure 7. Typical Broadband Circuit Performance

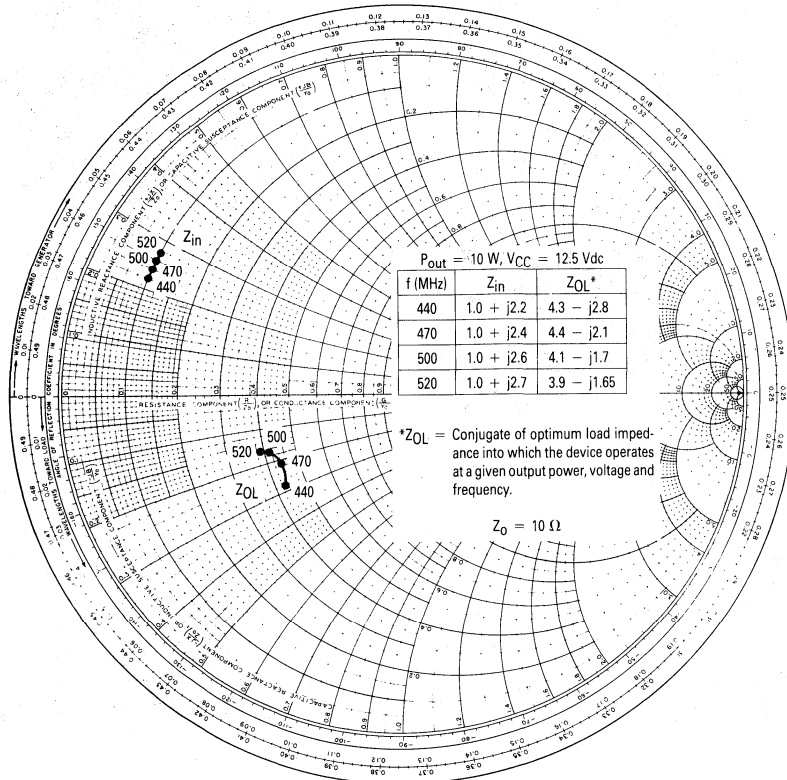


Figure 8. Series Equivalent Input and Output Impedance

MRF654

The RF Line

NPN SILICON RF POWER TRANSISTOR

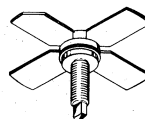
... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 512 MHz Characteristics
Output Power = 15 W
Minimum Gain = 7.8 dB
Efficiency = 55%
- Built-In Matching Network for Broadband Operation
- Gold Metallized, Emitter Ballasted for Long Life and Reliability
- Capable of 20:1 VSWR Load Mismatch at 15.5 V Supply Voltage

15 W 470 MHz

RF POWER TRANSISTOR

NPN SILICON

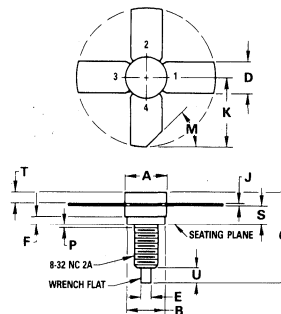


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	44 0.25	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	°C/W



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 25 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	31	45	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 15 \text{ W}$, $f = 512 \text{ MHz}$)	G_{pe}	7.8	8.8	—	dB
Collector Efficiency ($V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 15 \text{ W}$, $f = 512 \text{ MHz}$)	η	55	63	—	%
Load Mismatch Stress ($V_{CC} = 15.5 \text{ Vdc}$, $f = 470 \text{ MHz}$, 2.0 dB Overdrive, VSWR = 20:1 All Phase Angles)	$\#$	No Degradation In Output Power			

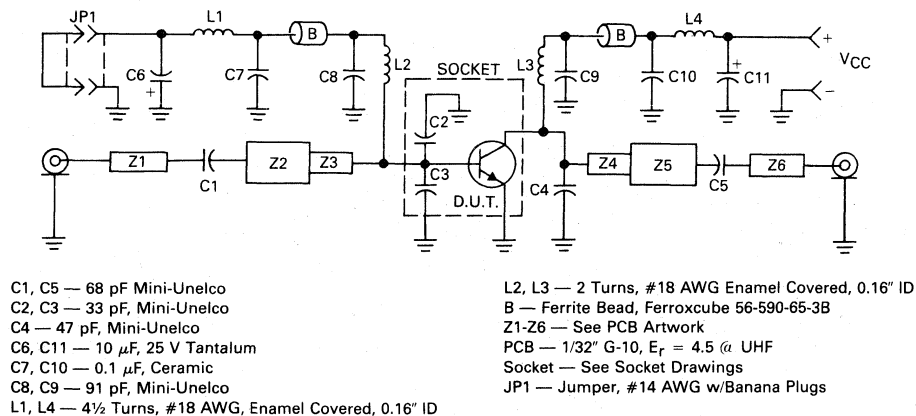
FIGURE 1 — 440–512 MHz BROADBAND TEST CIRCUIT

FIGURE 2 — OUTPUT POWER versus INPUT POWER

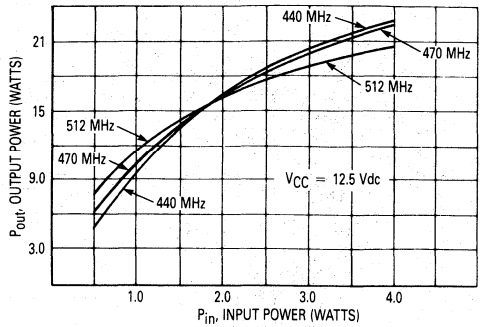


FIGURE 3 — OUTPUT POWER versus FREQUENCY

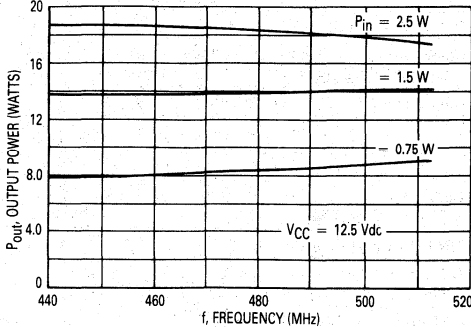


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

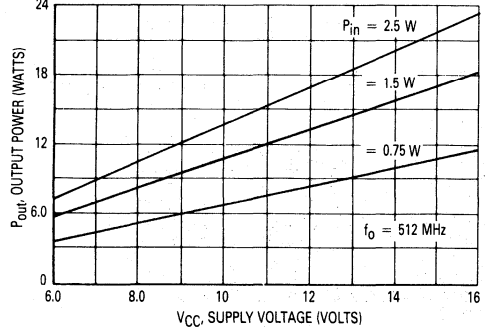


FIGURE 5 — TYPICAL BROADBAND CIRCUIT PERFORMANCE

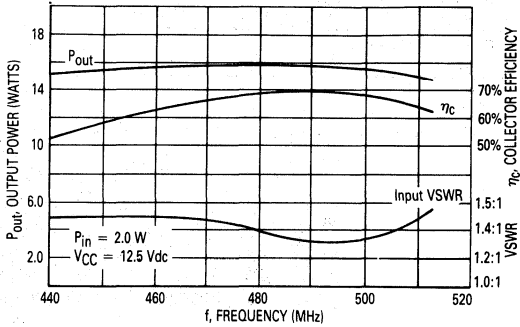


FIGURE 6 — SERIES EQUIVALENT INPUT AND OUTPUT IMPEDANCE

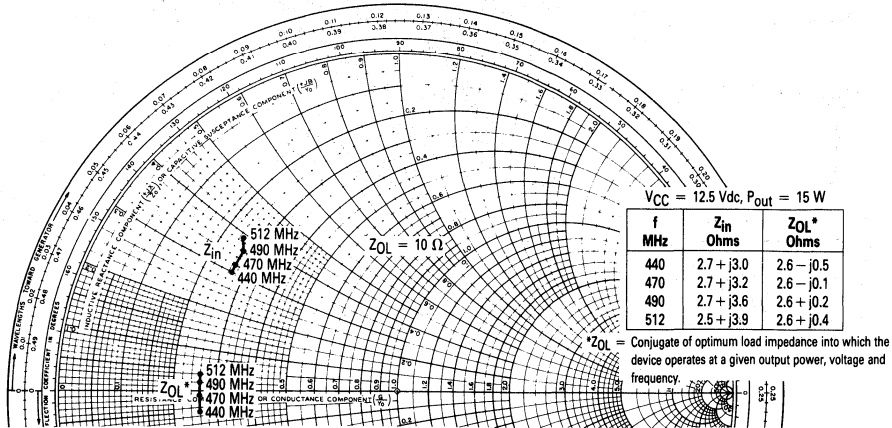
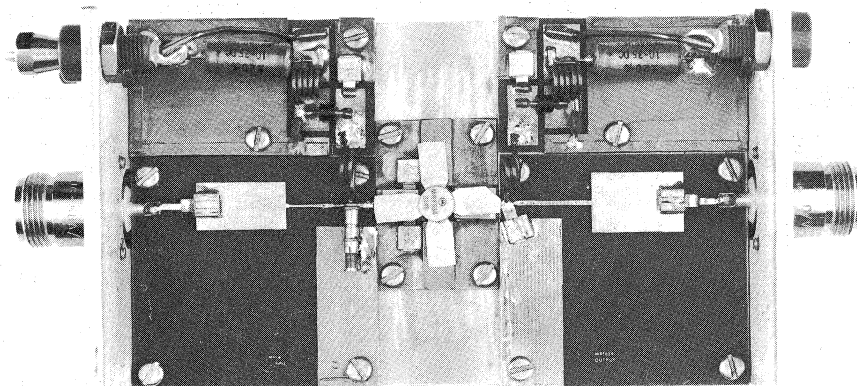
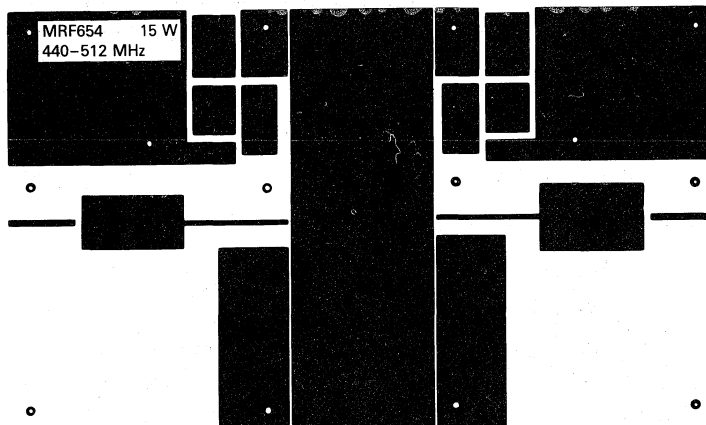


FIGURE 7 — 440-512 MHz BROADBAND TEST CIRCUIT



2

FIGURE 8 — PCB BOARD LAYOUT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF660

The RF Line

NPN SILICON RF POWER TRANSISTOR

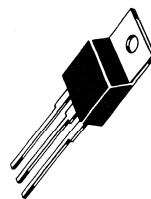
... designed for 12.5 volt UHF large signal power amplifier applications in commercial and industrial FM equipment.

- Low Cost Common Emitter TO-220AB Package
- Specified 12.5 V, 470 MHz Performance
 - Output Power = 7.0 W
 - Power Gain = 5.4 dB Min
 - Efficiency — 60% Min
- Load Mismatch Capability at High Line and RF Input Overdrive

7.0 W 470 MHz

RF POWER TRANSISTOR

NPN SILICON



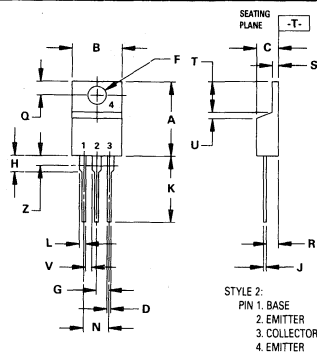
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1)	P_D	25	Watts
Derate above 25°C		143	mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7.0	$^\circ\text{C}/\text{W}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

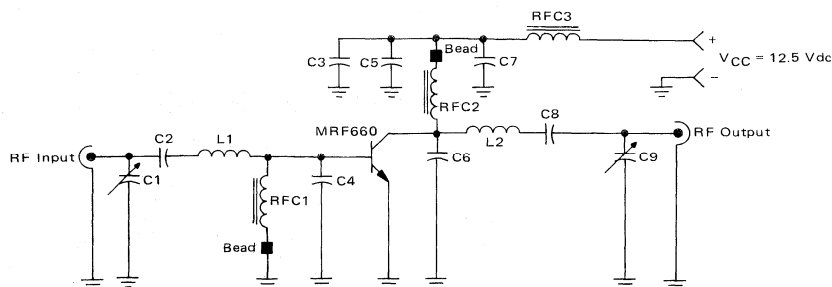
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.86	0.095	0.105
H	2.80	3.53	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	5.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	90	160	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	17	25	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 7.0\text{ W}$, $f = 470\text{ MHz}$)	G_{PE}	5.4	6.0	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 7.0\text{ W}$, $f = 470\text{ MHz}$)	η	60	—	—	%

FIGURE 1 — TEST CIRCUIT



C1, C9 — 1–10 pF Johanson
 C2, C8 — 15 pF Underwood Elect. Co. Type J101
 C3 — 270 pF, ATC Chip Capacitor Case B
 C4, C6 — 24 pF ELMENCO MCN01/010
 C5 — 0.1 μF Ceramic, Erie
 C7 — 1.0 μF , 35 V, Tantalum
 L1 — 27 nH Copper Strap 0.150" X 0.025" X 1.5" (See Note)
 L2 — 16 nH Copper Strap 0.150" X 0.025" X 1.0" (See Note)
 RFC1 — 0.68 μH Molded Choke, Cambion
 RFC2 — 4 Turns #20 AWG, 0.312" ID X 0.25" Long
 RFC3 — Ferrite Choke, Ferroxcube #VK200-20/4B
 Bead — Ferrite Bead, Ferroxcube #56-590-65-3B
 Printed Circuit Board Material — 3M #K6098-22062, Teflon Fiberglass or equivalent

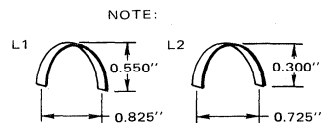


FIGURE 2 — OUTPUT POWER versus INPUT POWER

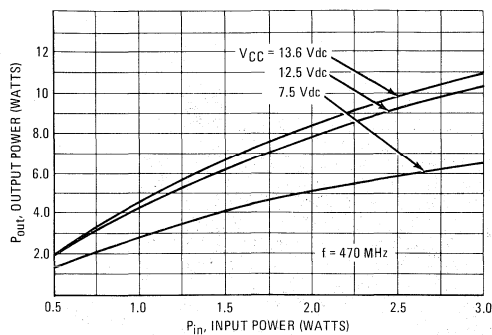


FIGURE 3 — OUTPUT POWER versus FREQUENCY

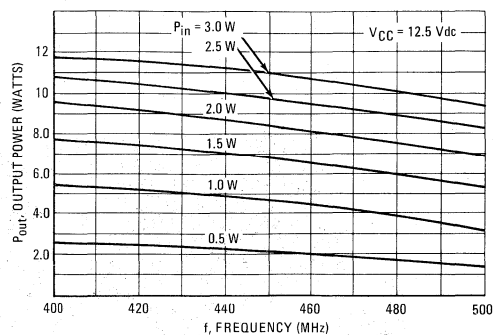


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

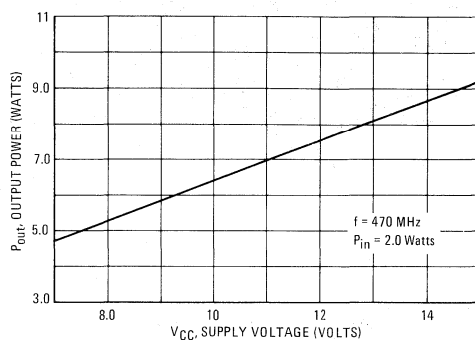
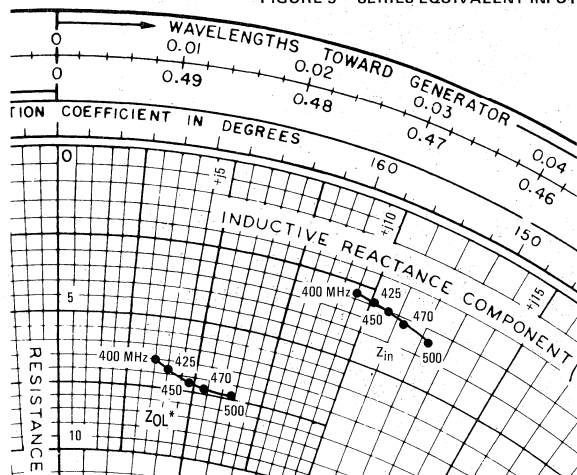


FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



$P_{in} = 2.0 \text{ W}$, $V_{CC} = 12.5 \text{ V}$

f MHz	Z_{in} Ohms	Z_{out}^* Ohms
400	$2.8 + j9.0$	$6.5 + j3.5$
425	$2.9 + j10.1$	$6.8 + j4.0$
450	$3.0 + j10.5$	$7.2 + j4.8$
470	$3.1 + j11.2$	$7.3 + j5.4$
500	$3.4 + j12.2$	$7.3 + j6.4$

* Z_{out}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 - UHF TEST AMPLIFIER

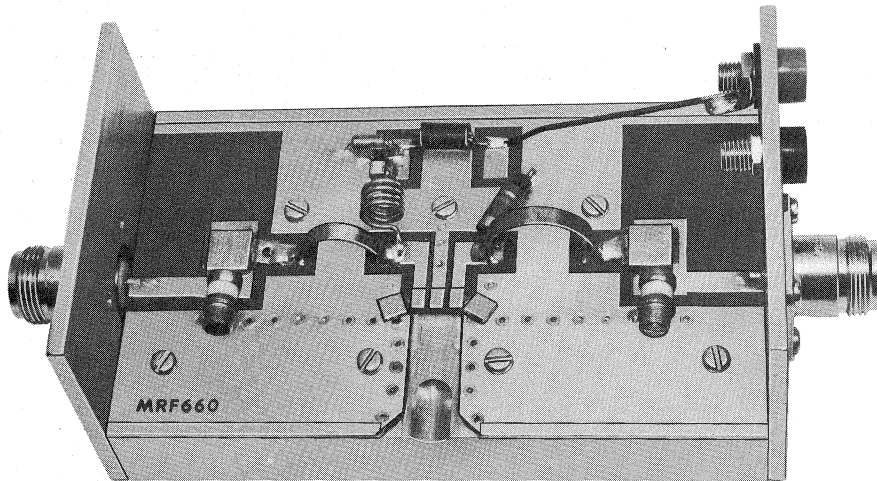
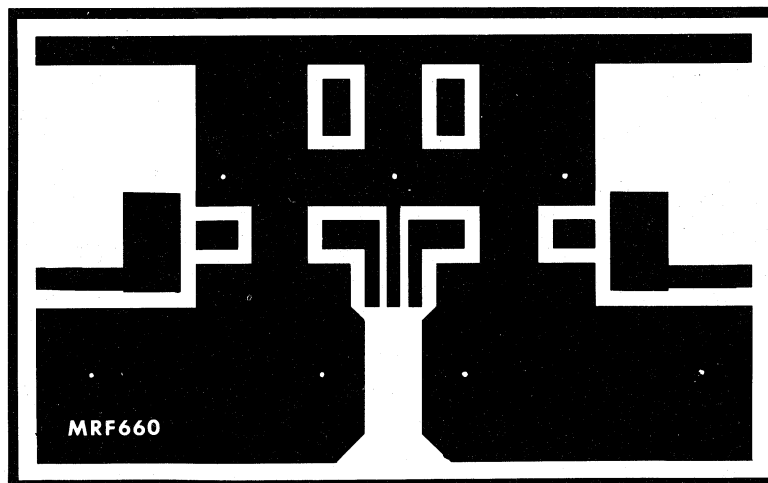


FIGURE 7 - PRINTED CIRCUIT BOARD



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF750

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

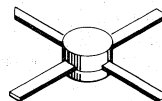
... designed for 5.0 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for handheld radios and other equipment where high packaging density is required.

- Specified 7.5 Volt, 470 MHz Characteristics —
Output Power = 0.5 Watts
Minimum Gain = 10 dB
Minimum Efficiency = 55%
- Capable of Withstanding Load Mismatch at Highline and RF Overdrive
- Silicon Nitride Passivation

0.5 W — 470 MHz — 7.5 V

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON



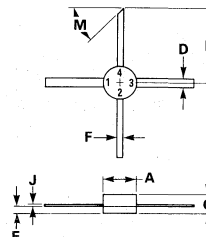
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current-Continuous	I_C	200	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	2.5 35	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150°C	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	28.5	°C/W

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

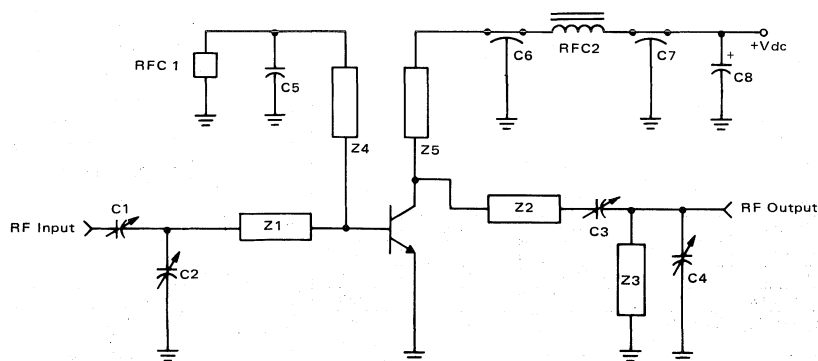
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.59	0.200	0.220
C	2.41	3.30	0.095	0.130
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45°	NOM	45°	NOM

CASE 305A-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 9.0 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50 \text{ mA}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	20	65	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 7.5 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	3.0	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 7.5 \text{ Vdc}$, $P_{out} = 0.5 \text{ W}$, $f = 470 \text{ MHz}$)	G_{PE}	10	11	—	dB
Collector Efficiency ($V_{CC} = 7.5 \text{ Vdc}$, $P_{out} = 0.5 \text{ W}$, $f = 470 \text{ MHz}$)	η	55	—	—	%

FIGURE 1 — 470 MHz TEST CIRCUIT



C1, C2, C3, C4, — Johanson Trimmer, JMC#5501
 C5 — J101, 100 pF Unelco
 C6, C7 — 680 pF Allen Bradley Feedthru
 C8 — 1.0 μF Tantalum
 RFC1 — Ferroxcube Bead, 56-590-65-3B
 RFC2 — Choke, VK 200/4B

Z1, Z2 — Microstrip $W = 0.26"$, $L = 2.9"$
 Z3 — Microstrip $W = 0.5"$, $L = 1.2"$
 Z4 — Microstrip $W = 0.055"$, $L = 3.9"$
 Z5 — Microstrip $W = 0.055"$, $L = 2.9"$
 Board Material — Glass Teflon, $t = 0.062$
 $\epsilon_r = 2.5$

FIGURE 2 – POWER GAIN versus FREQUENCY

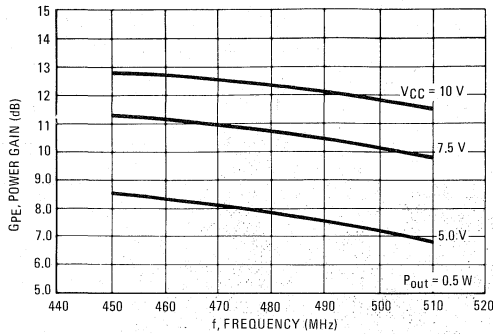


FIGURE 3 – OUTPUT POWER versus INPUT POWER
450 MHz

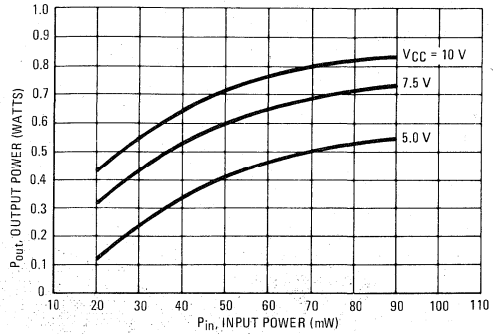


FIGURE 4 – OUTPUT POWER versus INPUT POWER
470 MHz

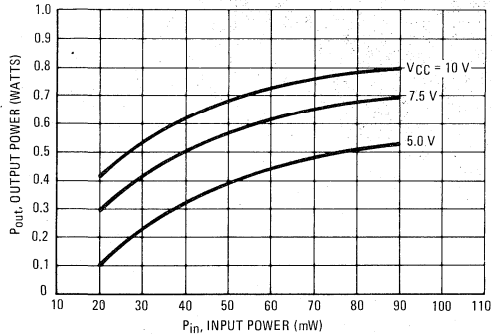


FIGURE 5 – OUTPUT POWER versus INPUT POWER
512 MHz

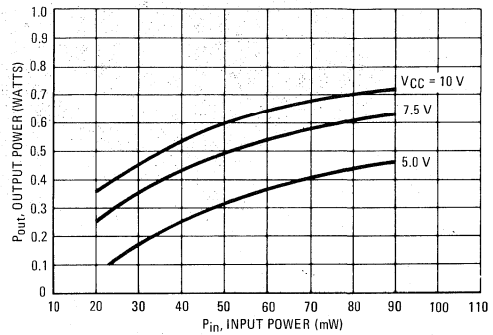
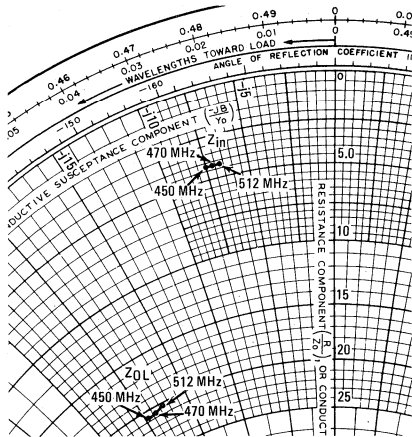


FIGURE 6 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

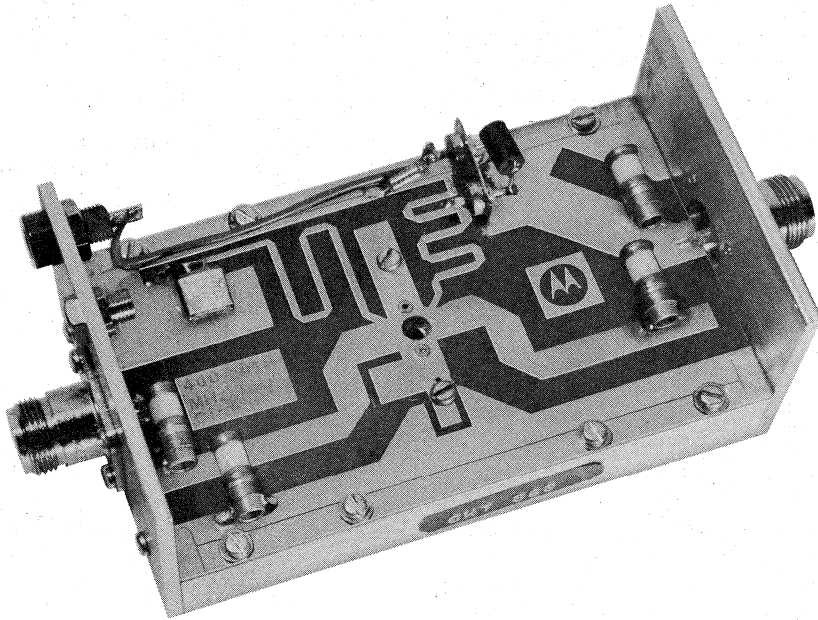


$P_{out} = 0.5\text{ W}$ $V_{CC} = 7.5\text{ V}$

f MHz	Z_{in} Ohms	Z_{out}^* Ohms
450	$4.4 - j7.5$	$20.9 - j19.7$
470	$4.4 - j7.1$	$20.7 - j18.9$
512	$4.4 - j6.7$	$20.1 - j17.6$

* Z_{out} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 — 470 MHz TEST CIRCUIT



MRF752

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

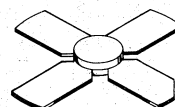
... designed for 5.0 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for handheld radios and other equipment where high packaging density is required.

- Specified 7.5 Volt, 470 MHz Characteristics —
 Output Power = 2.5 Watts
 Minimum Gain = 8.0 dB
 Minimum Efficiency = 55%
- Capable of Withstanding Load Mismatch at High Line and RF Overdrive

2.5 W — 470 MHz — 7.5 V

**HIGH FREQUENCY
 TRANSISTOR**

NPN SILICON



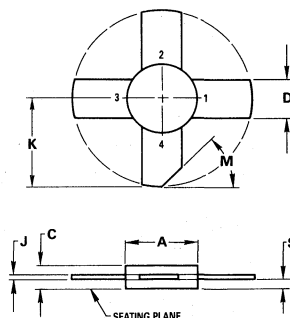
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current-Continuous	I_C	1.2	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	15 85.5	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	11.7	$^\circ\text{C/W}$

- (1) This device is designed for RF operation. The total device dissipation rating applied only when the device is operated as an RF amplifier.
 (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



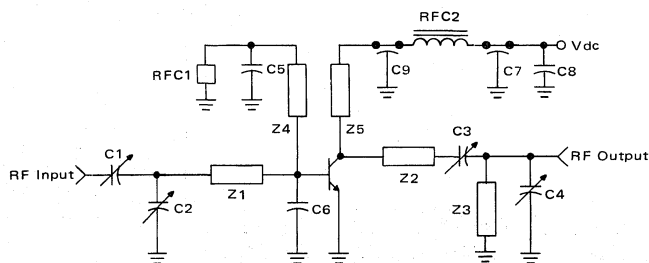
STYLE 1:
 PIN 1. EMITTER
 2. BASE
 3. EMITTER
 4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
C	2.84	3.45	0.112	0.136
D	5.46	5.97	0.215	0.235
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
S	1.40	1.65	0.055	0.065

CASE 249-05

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 25 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 3.0 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 9.0 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100 \text{ mA}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	20	85	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 7.5 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	27	35	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 7.5 \text{ Vdc}$, $P_{out} = 2.5 \text{ W}$, $f = 470 \text{ MHz}$)	G_{PE}	8.0	9.0	—	dB
Collector Efficiency ($V_{CC} = 7.5 \text{ Vdc}$, $P_{out} = 2.5 \text{ W}$, $f = 470 \text{ MHz}$)	η	55	—	—	%

FIGURE 1 – 470 MHz TEST CIRCUIT



C1, C2, C3, C4 - Johanson Trimmer JMC#5501
C5 - J101, 100 pF Unelco
C6 - J101, 15 pF Unelco
C7, C9 - 680 pF Allen Bradley Feedthru
C8 - 1.0 μ F Tantalum

Z1, Z2 – Microstrip W = 0.26", L = 2.9"
Z3 – Microstrip W = 0.5", L = 1.2"
Z4 – Microstrip W = 0.055", L = 3.9"
Z5 – Microstrip W = 0.055", L = 2.9"

RFC1 — Ferroxcube Bead, 56-590-65-3B
RFC2 — Choke, VK 200/4B

Board Material — Glass Teflon
 $t = 0.062$
 $\epsilon_r = 2.5$

FIGURE 2 — POWER GAIN versus FREQUENCY

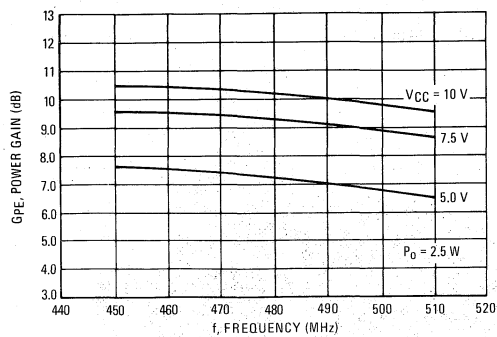
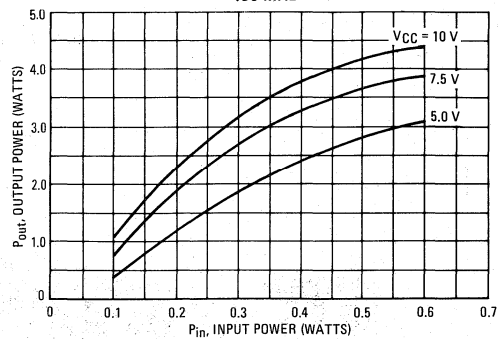
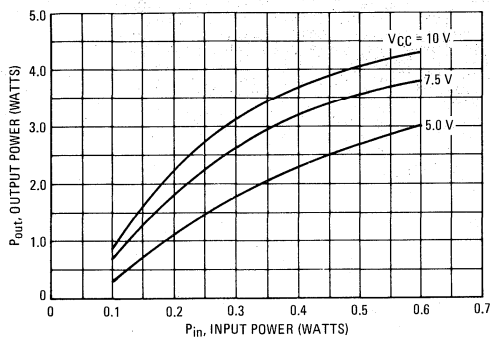
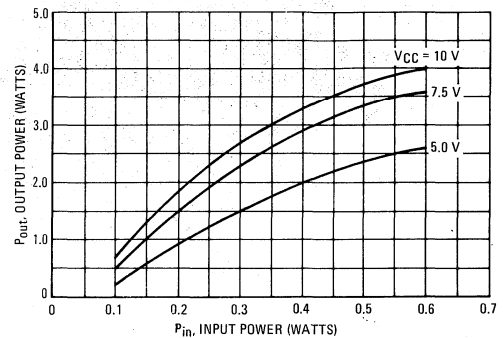
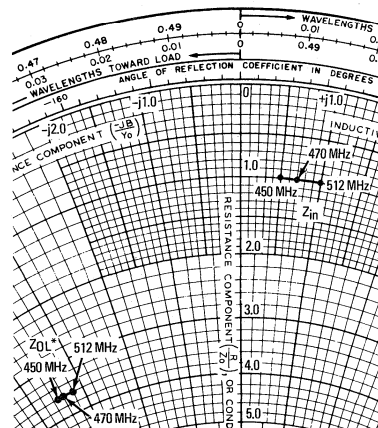
FIGURE 3 — OUTPUT POWER versus INPUT POWER
450 MHzFIGURE 4 — OUTPUT POWER versus INPUT POWER
470 MHzFIGURE 5 — OUTPUT POWER versus INPUT POWER
512 MHz

FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



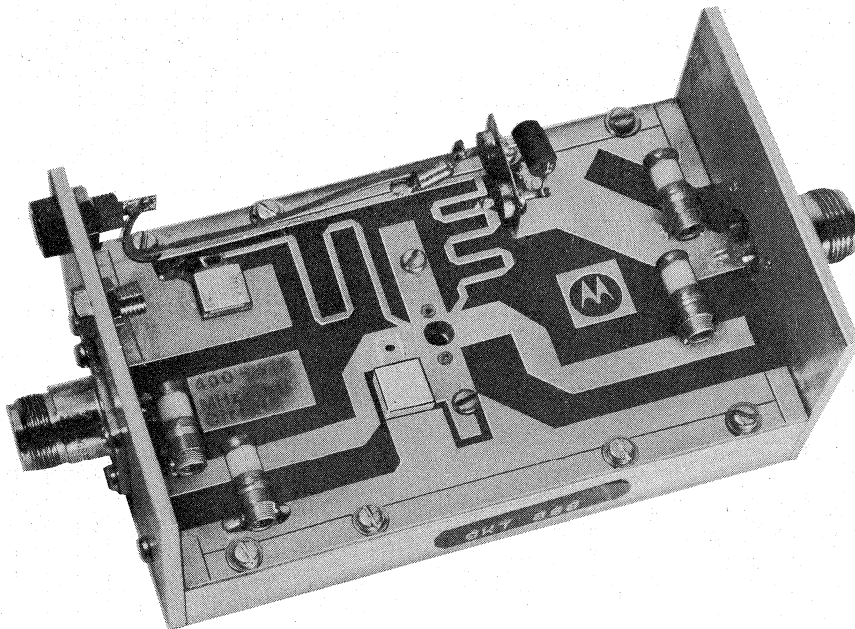
$P_{out} = 2.5 \text{ W}$, $V_{CC} = 7.5 \text{ V}$

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
450	$1.0 + j0.5$	$3.6 - j3.5$
470	$1.0 + j0.7$	$3.6 - j3.4$
512	$1.0 + j1.0$	$3.6 - j3.2$

* Z_{OL}^* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 - 470 MHz TEST CIRCUIT

2



MRF754

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

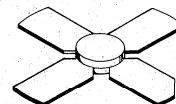
... designed for 5.0 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for handheld radios and other equipment where high packaging density is required.

- Specified 7.5 Volt, 470 MHz Characteristics —
Output Power = 8.0 Watts
Minimum Gain = 6.0 dB
Minimum Efficiency = 55%
- Capable of Withstanding Load Mismatch at Highline and RF Overdrive

8.0 W — 470 MHz — 7.5 V

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON



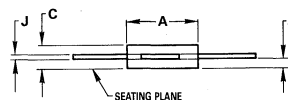
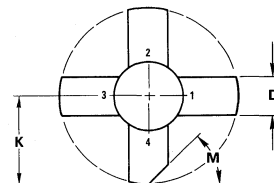
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	3.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	37.5 214	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150 $^\circ\text{C}$	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	4.7	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 2:

- PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR
SEATING PLANE =
GROUND AND IS
CONNECTED TO
PIN 1 AND PIN 3.

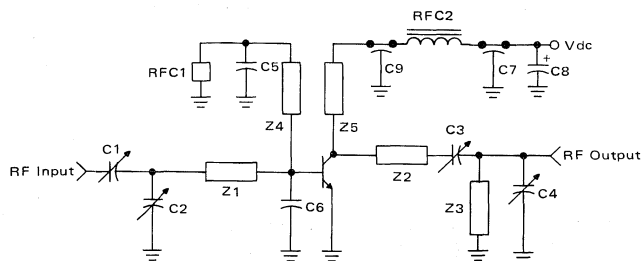
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
C	2.84	3.45	0.112	0.136
D	5.46	5.97	0.215	0.235
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45 $^\circ$ NOM		45 $^\circ$ NOM	
S	1.40	1.65	0.055	0.065

CASE 249-05

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 3.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 9.0\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 200\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	20	85	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 7.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	50	65	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 7.5\text{ Vdc}$, $P_{out} = 8.0\text{ W}$, $f = 470\text{ MHz}$)	G_{pE}	6.0	7.0	—	dB
Collector Efficiency ($V_{CC} = 7.5\text{ Vdc}$, $P_{out} = 8.0\text{ W}$, $f = 470\text{ MHz}$)	η	55	—	—	%

FIGURE 1 — 470 MHz TEST CIRCUIT



C1, C2, C3, C4 — Johanson Trimmer JMC#5501
 C5 — J101, 100 pF Unelco
 C6 — J101, 15 pF Unelco
 C7, C9 — 680 pF Allen Bradley Feedthru
 C8 — 1.0 μF Tantalum

Z1, Z2 — Microstrip $W = 0.26''$, $L = 2.9''$
 Z3 — Microstrip $W = 0.5''$, $L = 1.2''$
 Z4 — Microstrip $W = 0.055''$, $L = 3.9''$
 Z5 — Microstrip $W = 0.055''$, $L = 2.9''$

RFC1 — Ferroxcube Bead, 56-590-65-3B
 RFC2 — Choke, VK 200/4B

Board Material — Glass Teflon
 $t = 0.062$
 $\epsilon_r = 2.5$

FIGURE 2 — POWER GAIN versus FREQUENCY

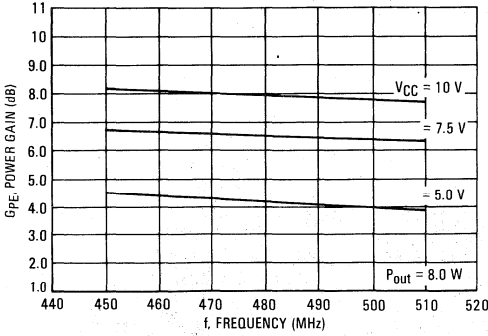


FIGURE 3 — OUTPUT POWER versus INPUT POWER
450 MHz

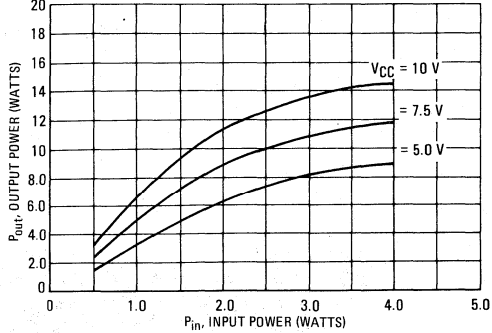


FIGURE 4 — OUTPUT POWER versus INPUT POWER
470 MHz

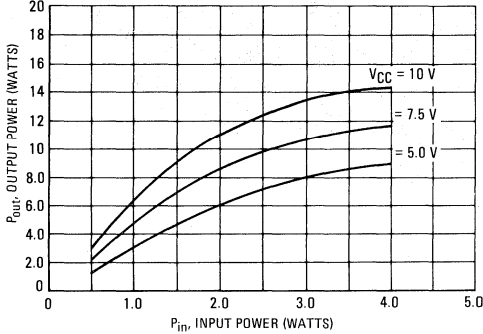


FIGURE 5 — OUTPUT POWER versus INPUT POWER
512 MHz

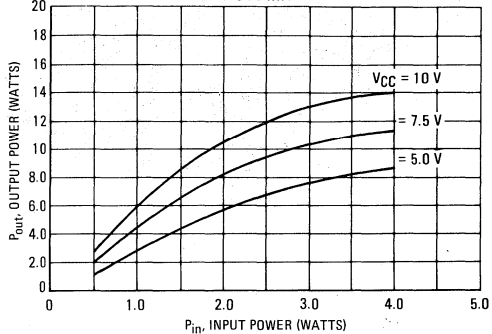
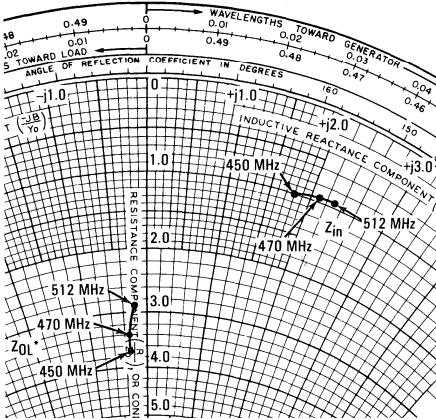


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

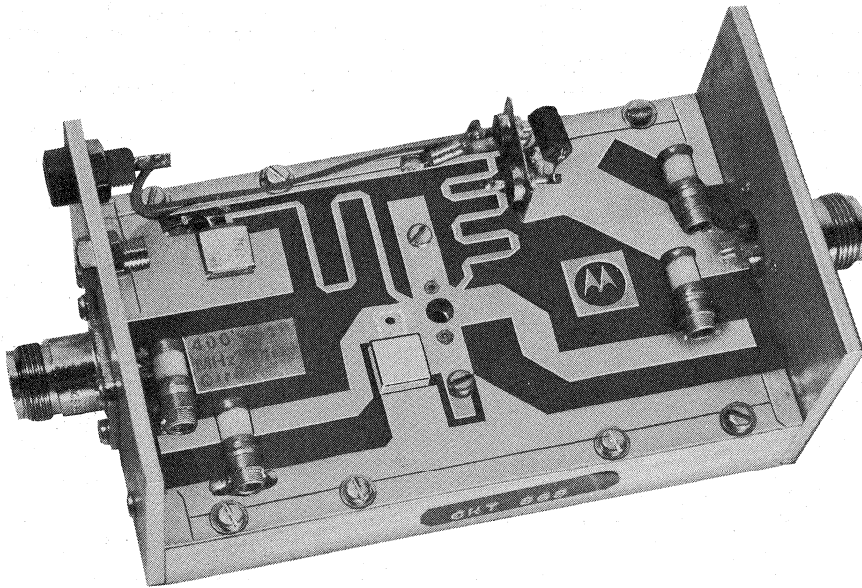


$P_{out} = 8.0\text{ W}$, $V_{CC} = 7.5\text{ V}$

f MHz	Z_{in} Ohms	Z_{out}^* Ohms
450	$1.0 + j1.8$	$3.7 - j0.3$
470	$0.9 + j2.1$	$3.4 - j0.3$
512	$0.9 + j2.3$	$2.9 - j0.2$

* Z_{out} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 — 470 MHz TEST CIRCUIT



MOTOROLA SEMICONDUCTOR TECHNICAL DATA

MRF837

The RF Line

NPN SILICON RF LOW POWER TRANSISTOR

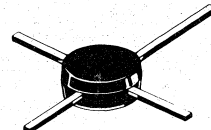
... designed primarily for wideband large signal predriver stages in 800 MHz and UHF frequency ranges.

- Specified @ 12.5 V, 870 MHz Characteristics
Output Power = 750 mW
Minimum Gain = 8.0 dB
Efficiency 60% (Typ)
- Low Cost Macro-X Plastic Package
- State-of-the-Art Technology
Fine Line Geometry
Gold Top Metal and Wires
Silicon Nitride Passivated
Ion Implanted Arsenic Emitters

750 mW 870 MHz

RF LOW POWER TRANSISTOR

NPN SILICON



Macro-X

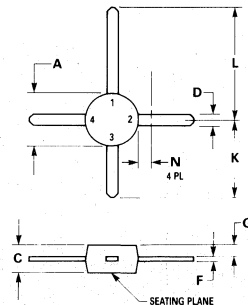
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	200	mA dc
Total Device Dissipation @ $T_C = 50^\circ\text{C}$ Derate above 50°C (1)	P_D	2.5 25	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_J, T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	$^\circ\text{C/W}$

(1) Case temperature measured on collector lead immediately adjacent to body of package.



STYLE 2:

- PIN 1. COLLECTOR
- 2. EMITTER
- 3. BASE
- 4. EMITTER

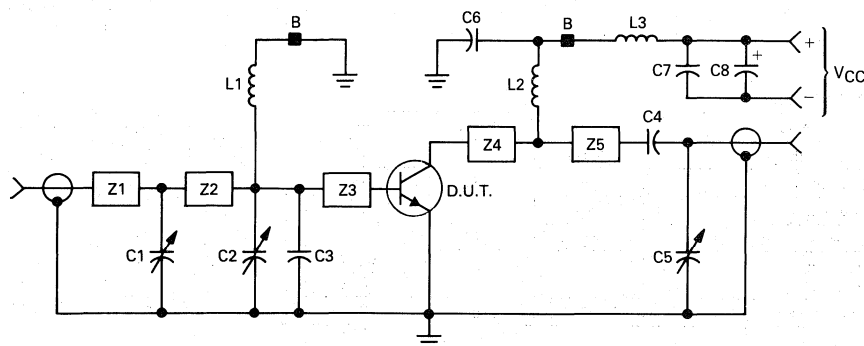
NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	0.1	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	30	90	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	1.8	2.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.75\text{ W}$, $f = 870\text{ MHz}$)	G_{pe}	8.0	10	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.75\text{ W}$, $f = 870\text{ MHz}$)	η	55	60	—	%

FIGURE 1 — 800–880 MHz BROADBAND CIRCUIT

C1, C2, C5 — 0.8–8.0 pF Johanson Gigatrim
 C3 — 5.0 pF Clamped Mica, Mini-Underwood
 C6 — 91 pF Clamped Mica, Mini-Underwood
 C4 — 470 pF Ceramic Chip Capacitor
 C7 — 68 pF Clamped Mica, Mini-Underwood
 C8 — 1.0 μF 25 V Tantalum
 B — Bead, Ferroxcube 56-590-65/3B

L1, L2 — 4 Turns, #21 AWG, 5/32" ID
 L3 — 7 Turns, #21 AWG, 5/32" ID
 Z1 — 0.80" x 0.163" Microstrip, $Z_0 = 50\ \Omega$
 Z2 — 1.375" x 0.163" Microstrip, $Z_0 = 50\ \Omega$
 Z3, Z4 — 0.375" x 0.163" Microstrip, $Z_0 = 50\ \Omega$
 Z5 — 1.35" x 0.163" Microstrip, $Z_0 = 50\ \Omega$
 PCB — 1/16" Glass Teflon, $\epsilon_r = 2.56$

FIGURE 2 — 800-880 BROADBAND CIRCUIT

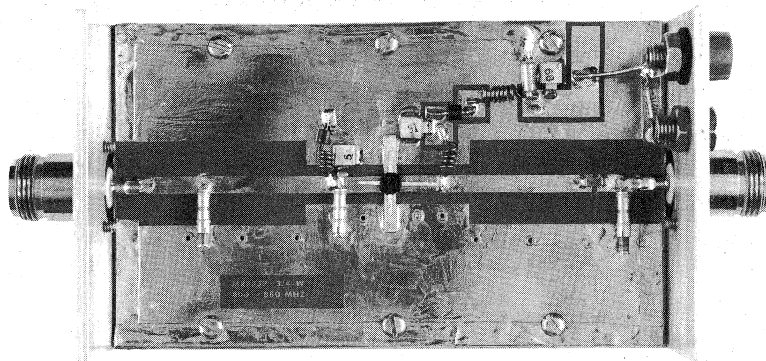
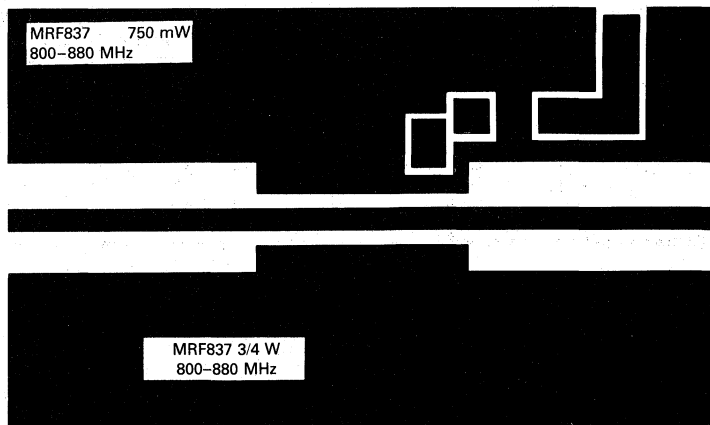


FIGURE 3 — 800-880 MHz BROADBAND CIRCUIT PHOTOMASTER



NOTE: The Printed Circuit Board shown is 75% of the original.

800/900 MHz BAND DATA

FIGURE 4 — BROADBAND PERFORMANCE

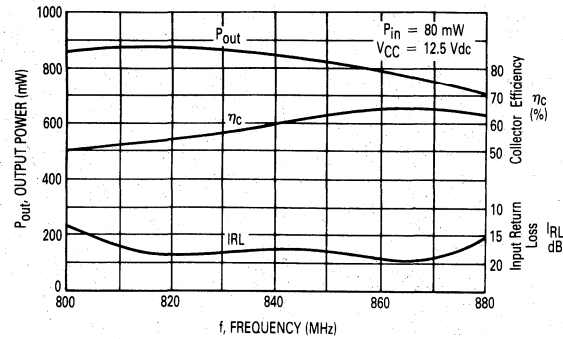


FIGURE 5 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER AND OUTPUT POWER

f Frequency MHz	Z _{in} Ohms		Z _{OL} * Ohms	
	V _{CC} = 7.5 V	V _{CC} = 12.5 V	V _{CC} = 7.5 V	V _{CC} = 12.5 V
	P _{in} = 150 mW	P _{in} = 100 mW	P _{out} 806 MHz = 870 mW P _{out} 870 MHz = 820 mW P _{out} 960 MHz = 700 mW	P _{out} 806 MHz = 1.05 W P _{out} 870 MHz = 950 mW P _{out} 960 MHz = 725 mW
806	6.1 + j3.6	4.3 + j0.6	38.3 - j16.4	23.2 - j31.6
870	5.6 + j5.2	6.5 + j3.6	40.8 - j18.9	41.3 - j18.4
960	6.1 + j6.8	6.4 + j4.5	43.8 - j14.7	41.4 - j19.0

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

800/900 MHz BAND DATA (continued)

FIGURE 6 — OUTPUT POWER versus
INPUT POWER
 $f = 870 \text{ MHz}$

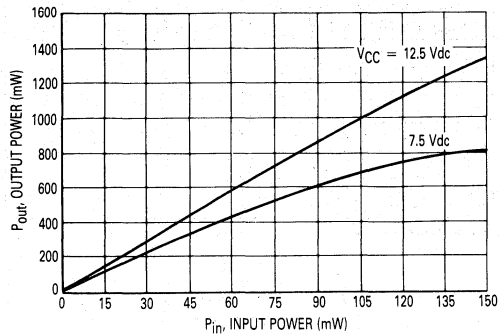


FIGURE 8 — OUTPUT POWER versus
COLLECTOR VOLTAGE
 $f = 870 \text{ MHz}$

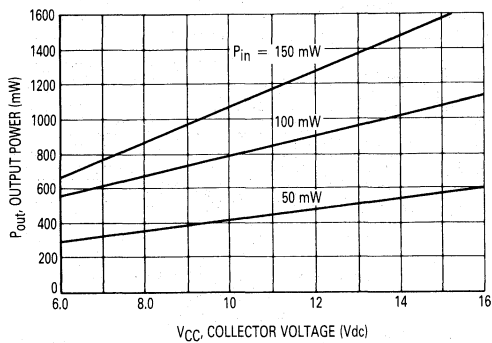


FIGURE 7 — OUTPUT POWER versus
FREQUENCY
 $V_{CC} = 7.5 \text{ Vdc}$

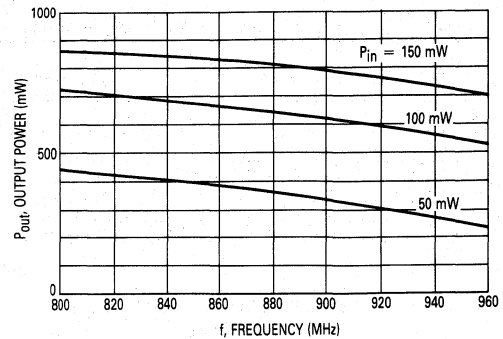
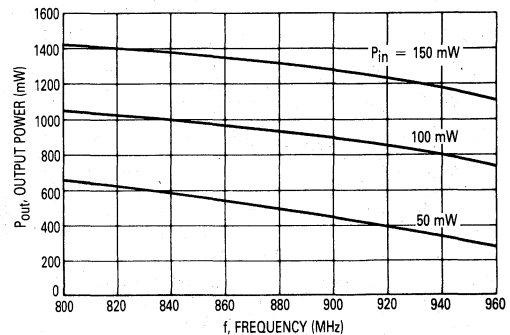


FIGURE 9 — OUTPUT POWER versus
FREQUENCY
 $V_{CC} = 12.5 \text{ Vdc}$

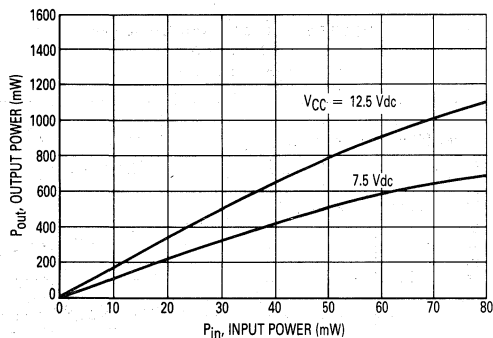
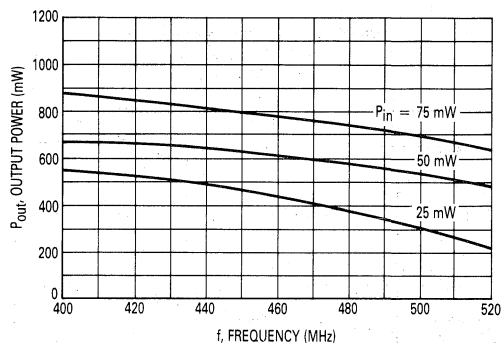
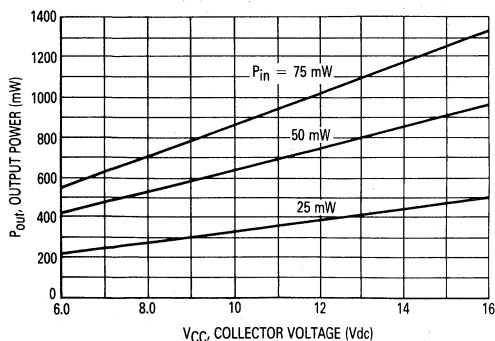
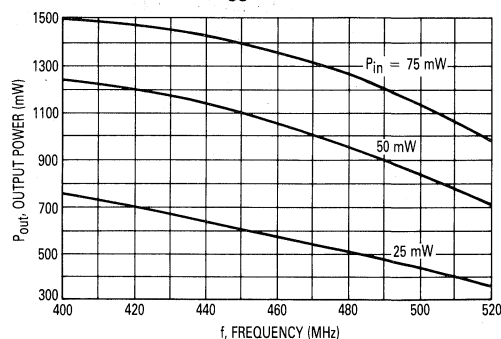


UHF BAND DATA

FIGURE 10 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

f Frequency MHz	Z_{in} Ohms		Z_{OL}^* Ohms	
	$V_{CC} = 7.5 \text{ V}$	$V_{CC} = 12.5 \text{ V}$	$V_{CC} = 7.5 \text{ V}$	$V_{CC} = 12.5 \text{ V}$
	$P_{in} = 75 \text{ mW}$	$P_{in} = 50 \text{ mW}$	$P_{out} \text{ 400 MHz} = 875 \text{ mW}$ $P_{out} \text{ 450 MHz} = 790 \text{ mW}$ $P_{out} \text{ 512 MHz} = 675 \text{ mW}$	$P_{out} \text{ 400 MHz} = 1.25 \text{ W}$ $P_{out} \text{ 450 MHz} = 1.1 \text{ W}$ $P_{out} \text{ 512 MHz} = 775 \text{ mW}$
400	$9.6 - j7.5$	$8.2 - j11.5$	$37.8 + j12.3$	$51.8 - j7.2$
450	$11.3 - j7.5$	$9.7 - j11$	$35.8 + j8.6$	$52.2 - j16.7$
512	$11.5 - j6.8$	$12 - j9.2$	$42.4 + j0.24$	$43.7 - j5.7$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 11 — OUTPUT POWER versus
INPUT POWER
f = 512 MHzFIGURE 12 — OUTPUT POWER versus
FREQUENCY
 $V_{CC} = 7.5 \text{ Vdc}$ FIGURE 13 — OUTPUT POWER versus
COLLECTOR VOLTAGE
f = 512 MHzFIGURE 14 — OUTPUT POWER versus
FREQUENCY
 $V_{CC} = 12.5 \text{ Vdc}$ 

MRF838
MRF838A

The RF Line

NPN SILICON RF POWER TRANSISTORS

...designed for 12.5 volt UHF large-signal, common-emitter amplifier applications in industrial and commercial FM equipment operating in the range of 806-960 MHz.

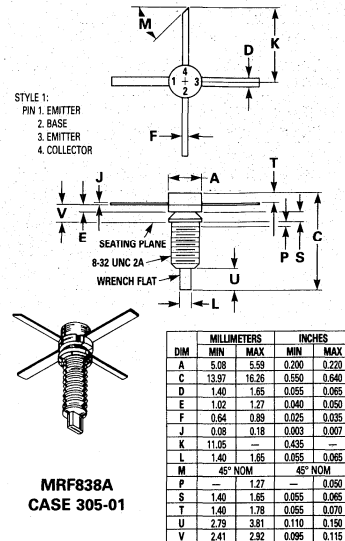
- Specified 12.5 Volt, 870 MHz Characteristics:
Output Power = 1.0 Watt
Minimum Gain = 6.5 dB
Efficiency = 60% Typ
- Series Equivalent Large-Signal Characterization

1 W-870 MHz

RF POWER TRANSISTORS

NPN SILICON

2



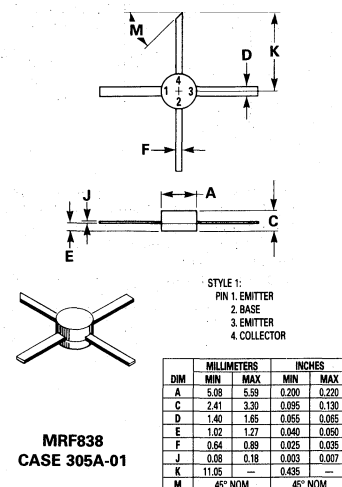
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	16	V _{dc}
Collector-Base Voltage	V _{CBO}	36	V _{dc}
Emitter-Base Voltage	V _{EBO}	4.0	V _{dc}
Collector Current - Continuous	I _C	0.3	A _{dc}
Total Device Dissipation @ T _C = 25°C (1) Derate Above 25°C	P _D	2.5 0.014	Watts W/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	R _{θJC}	70	°C/W

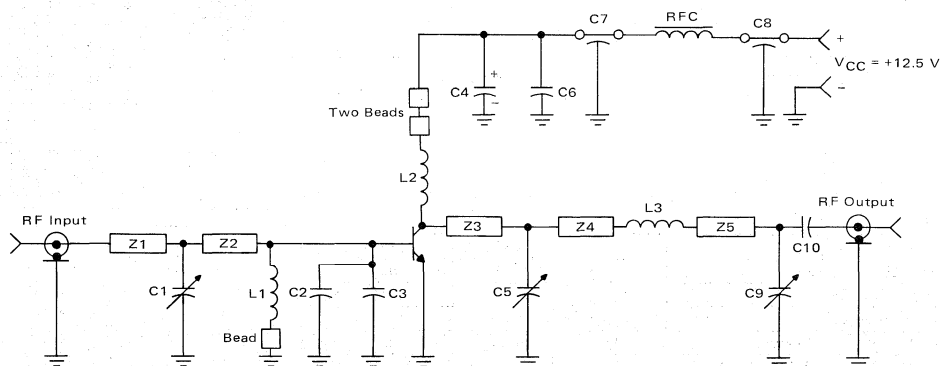
- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	80	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	5.0	7.0	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($P_{out} = 1.0\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 870\text{ MHz}$)	G_{PE}	6.5	7.5	—	dB
Collector Efficiency ($P_{out} = 1.0\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 870\text{ MHz}$)	η	50	60	—	%

FIGURE 1 — 870 MHz TEST CIRCUIT



C1, C5, C9 — 0.8–8.0 pF Johanson Gigatrim #7291
 C2, C3 — 10 pF ATC Chip Capacitor (Case A)
 C4 — 1.0 μF 30 V Tantalum Capacitor
 C6 — 0.1 μF Erie Redcap 100 V
 C7, C8 — 680 pF Feedthru
 C10 — 100 pF Chip Capacitor (100 mil)
 L1, L2 — 1 Turn #18 AWG 1/8" Diameter
 L3 — #14 AWG 1/2 Turn 0.250" Diameter

RFC — Ferroxcube VK200 20/4B

Bead — Ferroxcube #56-590-65/3B

Z1, Z2 — 1.2" X 0.155" Microstrip

Z3 — 1.05" X 0.155" Microstrip

Z4 — 0.5" X 0.155" Microstrip

Z5 — 1.5" X 0.155" Microstrip

Board Material — 0.0625" Thick Glass-Teflon, $\epsilon_r = 2.5$

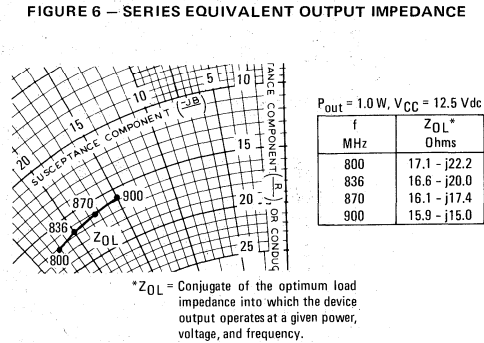
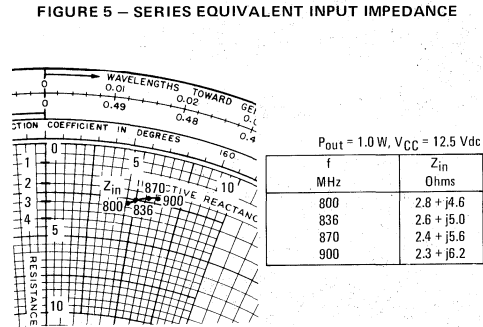
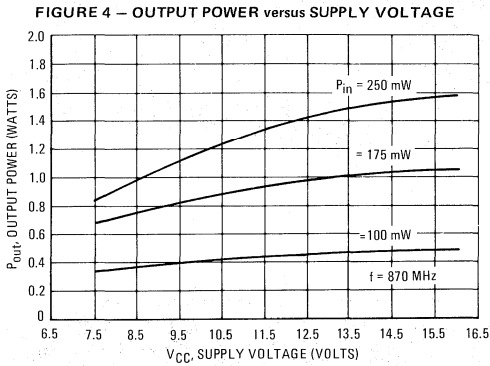
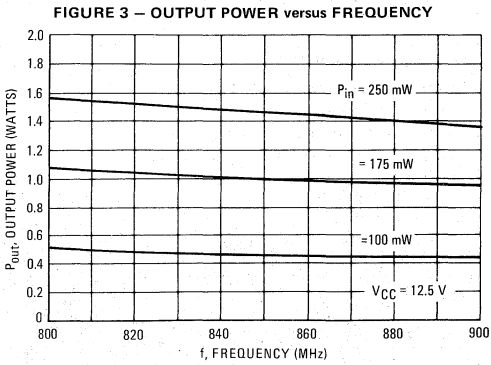
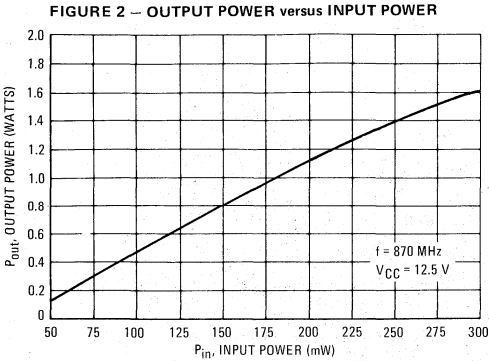
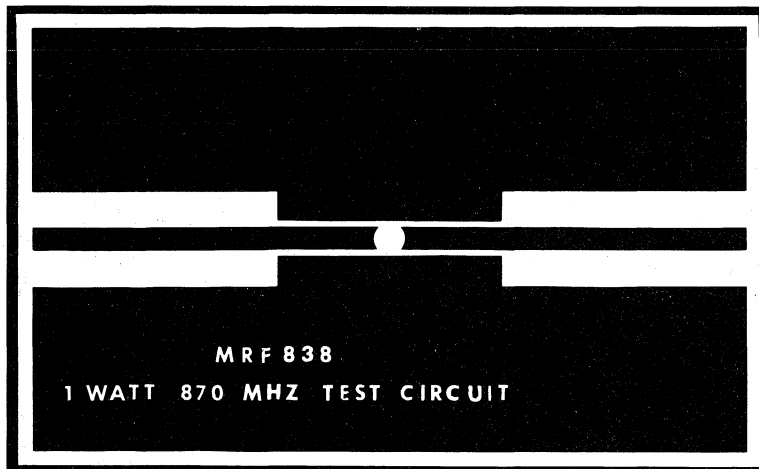
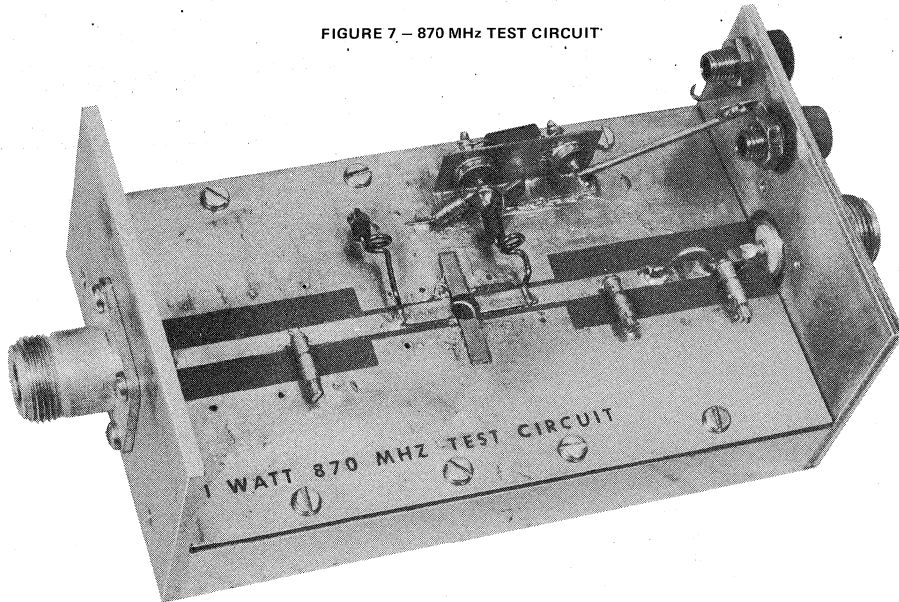


FIGURE 7 - 870 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line
NPN Silicon
RF Power Transistors

... designed for 12.5 Volt UHF large-signal, **common-emitter** amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 V 870 MHz Characteristics
 - Output Power = 3 Watts
 - Minimum Gain = 8 dB
 - Minimum Efficiency = 55%
- 100% Tested for Load Mismatch at Rated Input Power and 15.5 V
- Series Equivalent Large-Signal Characterization

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	0.6	Adc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ $T_C = 110^\circ\text{C}$ Derate above 110°C	P_D	10 111	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	9	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100 \text{ mAdc}$, $V_{CE} = 5 \text{ Vdc}$)	h_{FE}	10	90	150	—
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DYNAMIC CHARACTERISTICS

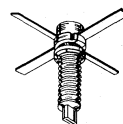
Output Capacitance ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	6.5	10	pF
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FUNCTIONAL TESTS (FIGURE 1)

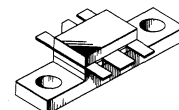
Common-Emitter Amplifier Power Gain ($P_{out} = 3 \text{ W}$, $V_{CC} = 12.5 \text{ Vdc}$, $f = 870 \text{ MHz}$)	G_{PE}	8	10	—	dB
Collector Efficiency ($P_{out} = 3 \text{ W}$, $V_{CC} = 12.5 \text{ Vdc}$, $f = 870 \text{ MHz}$)	η_c	55	63	—	%
Load Mismatch Stress ($V_{CC} = 15.5 \text{ Vdc}$, $P_{in} = 0.5 \text{ W}$, $f = 870 \text{ MHz}$, $V_{SWR} = 20:1$, all phase angles)	—	No Degradation in Output Power			

MRF839
MRF839F

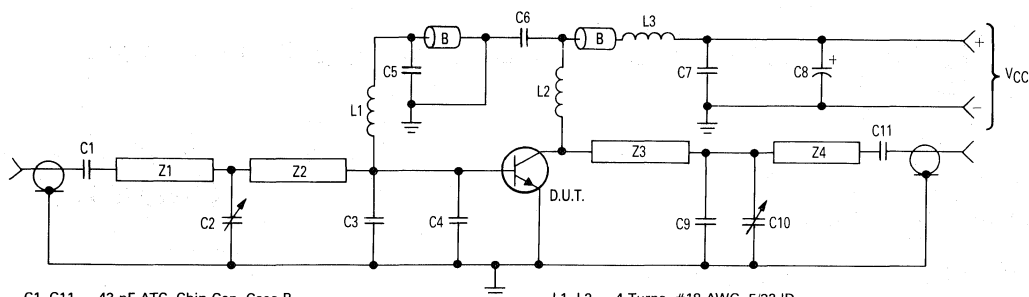
3 W 806–960 MHz
RF POWER
TRANSISTORS
COMMON-EMITTER
NPN SILICON



CASE 305-01, STYLE 1
MRF839



CASE 319-06, STYLE 2
MRF839F



C1, C11 — 43 pF ATC, Chip Cap, Case B
 C2, C10 — 0.8-8 Johanson Gigatrim
 C3, C4 — 10 pF Clamped Mica, Mini-Underwood
 C5, C6, C7 — 68 pF Clamped Mica, Mini-Underwood
 C8 — 10 μ F, 25 V Tantalum
 C9 — 5 pF Clamped Mica, Mini-Underwood
 B — Bead, Ferroxcube #56-590-65/3B

L1, L2 — 4 Turns, #18 AWG, 5/32 ID
 L3 — 7 Turns, #18 AWG, 5/32 ID
 Z1 — 0.850" \times 0.077" Microstrip, $Z_0 = 50 \Omega$
 Z2 — 1.100" \times 0.077" Microstrip, $Z_0 = 50 \Omega$
 Z3 — 0.920" \times 0.077" Microstrip, $Z_0 = 50 \Omega$
 Z4 — 1.150" \times 0.077" Microstrip, $Z_0 = 50 \Omega$
 Board Material — 0.032" Glass Teflon, 2 oz. Copper Clad, $\epsilon_r = 2.55$

Figure 1. MRF839 800-880 MHz Broadband Test Circuit

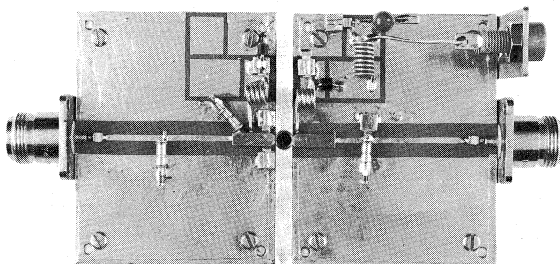


Figure 2. MRF839 Broadband Test Circuit

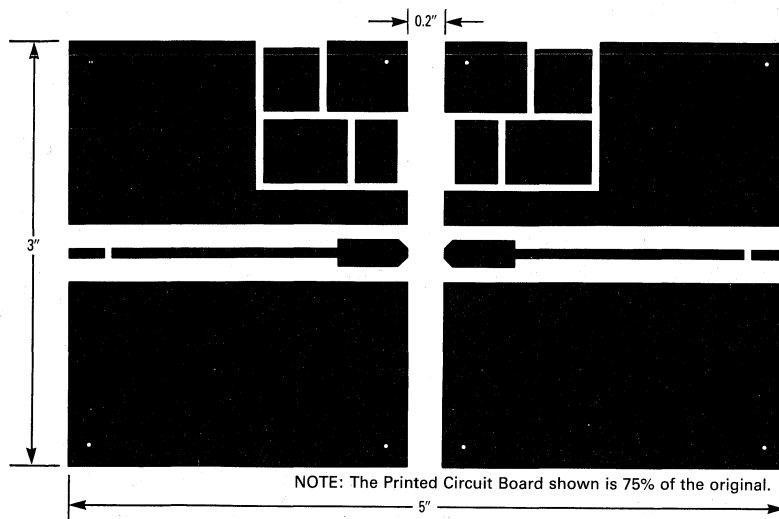


Figure 3. MRF839 Photomaster

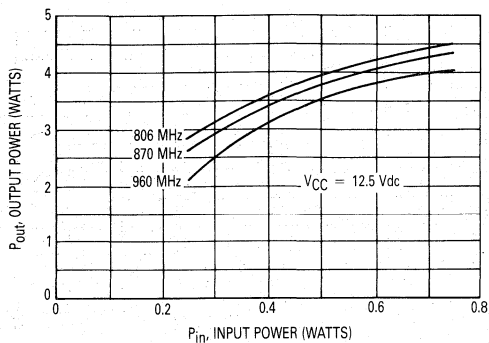


Figure 4. Output Power versus Input Power

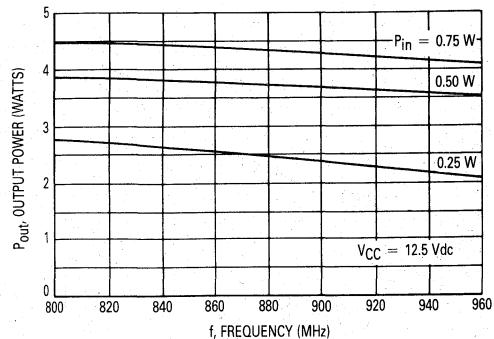


Figure 5. Output Power versus Frequency

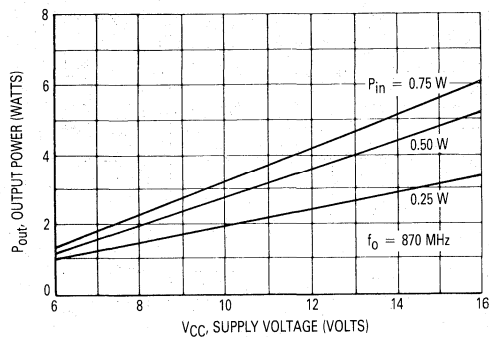


Figure 6. Output Power versus Supply Voltage

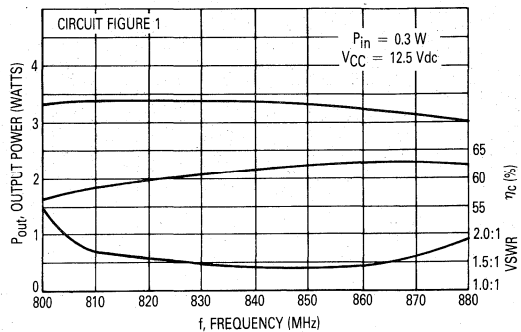


Figure 7. Broadband Performance

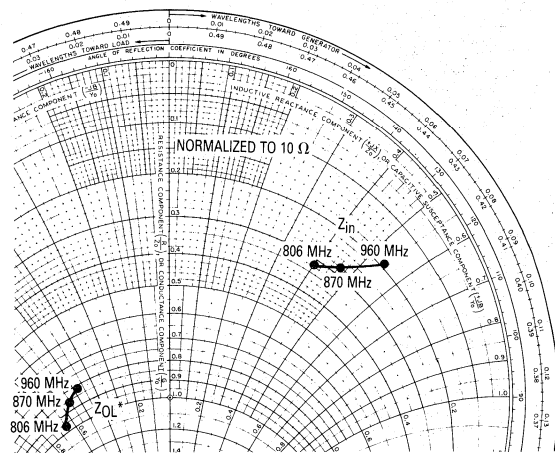


Figure 8. Series Equivalent Input/Output Impedances

$P_{out} = 3 \text{ Watts}, V_{CC} = 12.5 \text{ Vdc}$

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
806	$3.1 + j4.0$	$9.6 - j6.5$
870	$2.8 + j4.6$	$8.5 - j5.6$
960	$1.9 + j5.4$	$8.1 - j4.8$

* Z_{OL} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

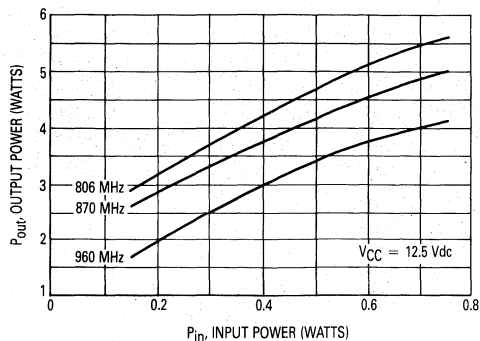


Figure 9. Output Power versus Input Power

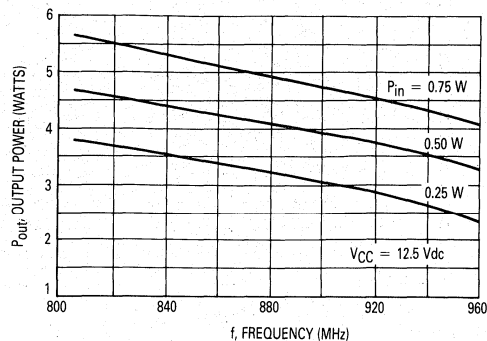


Figure 10. Output Power versus Frequency

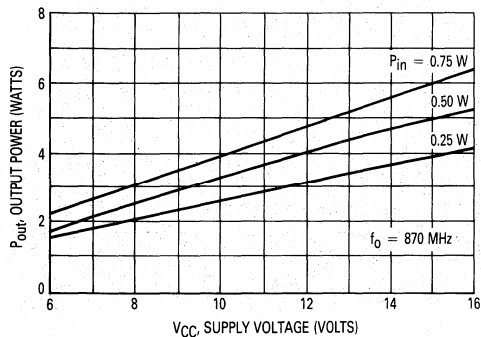


Figure 11. Output Power versus Supply Voltage

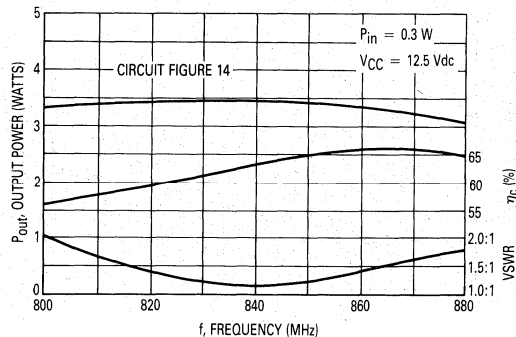


Figure 12. Broadband Performance

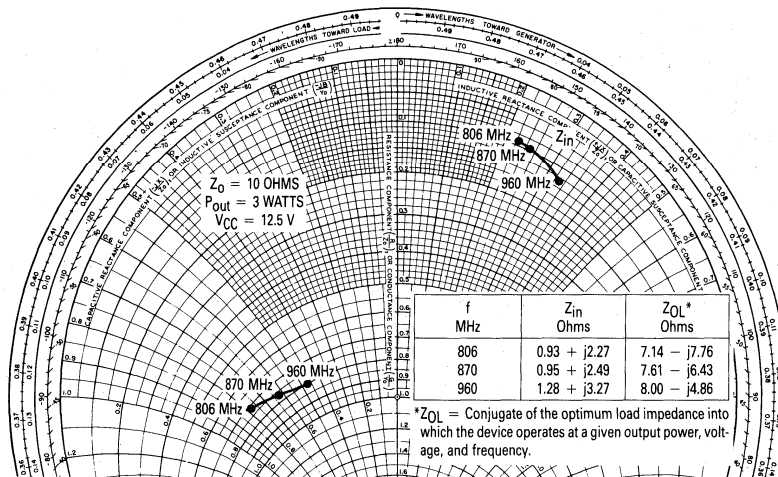


Figure 13. Series Equivalent Input/Output Impedances

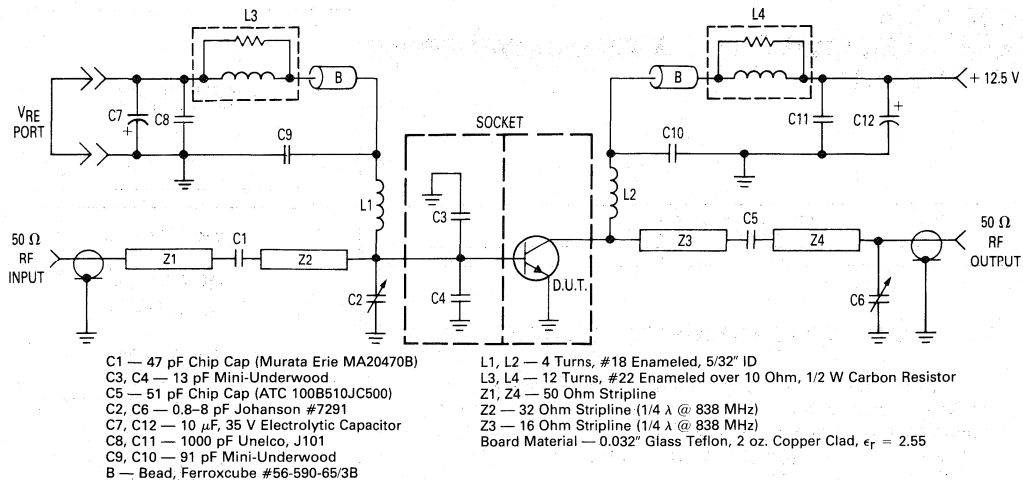


Figure 14. MRF839F 800–880 MHz Broadband Test Circuit

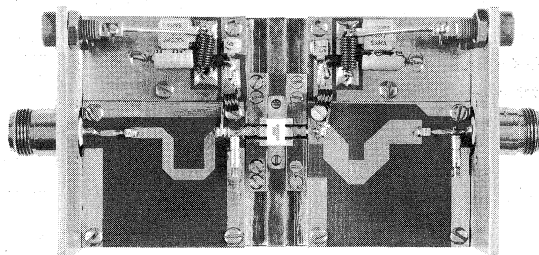


Figure 15. MRF839F Broadband Test Circuit

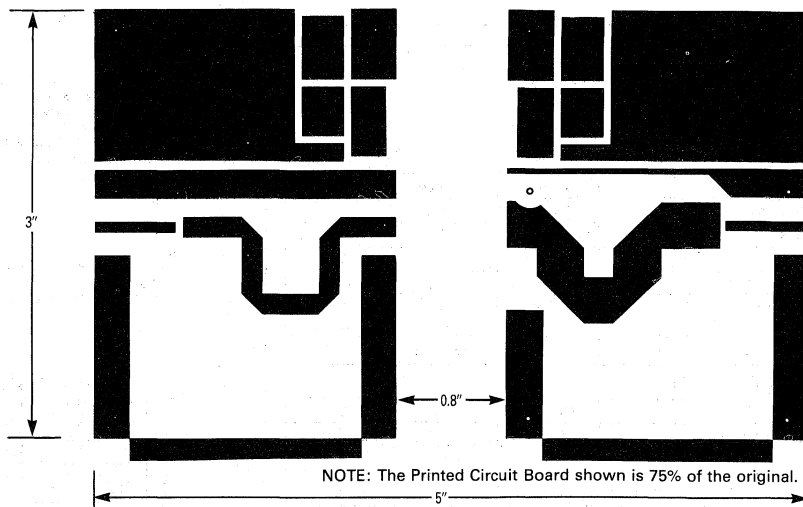


Figure 16. MRF839F Photomaster

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806-960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
 Output Power = 10 Watts
 Minimum Gain = 6.0 dB
 Efficiency = 50%
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at All Phase Angles with 20:1 VSWR @ 15.5 Volt Supply and 50% RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current - Continuous	I_C	3.8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	40 0.32	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	3.1	$^\circ\text{C/W}$

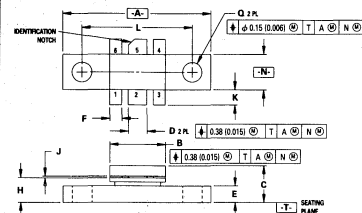
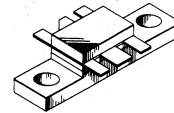
- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
 (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF840

10 W - 870 MHz

RF POWER TRANSISTOR

NPN SILICON



STYLE 1:

- PIN 1. BASE (COMMON)
- EMITTER (INPUT)
- BASE (COMMON)
- BASE (COMMON)
- COLLECTOR (OUTPUT)
- BASE (COMMON)

- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42	BSC	0.725	BSC
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

FIGURE 2 — OUTPUT POWER versus INPUT POWER

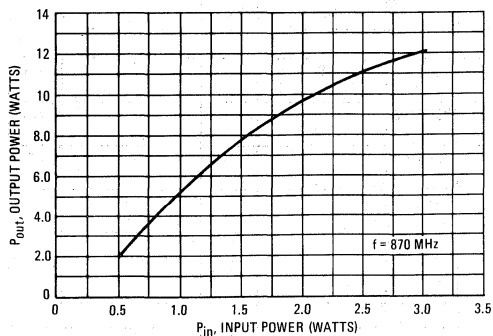


FIGURE 3 — OUTPUT POWER versus FREQUENCY

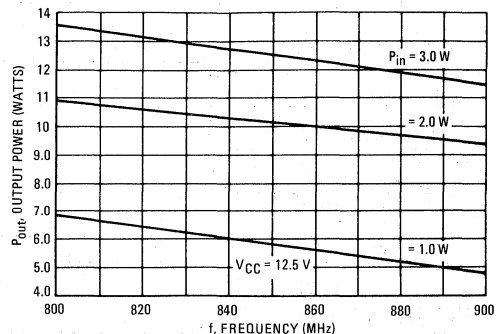


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

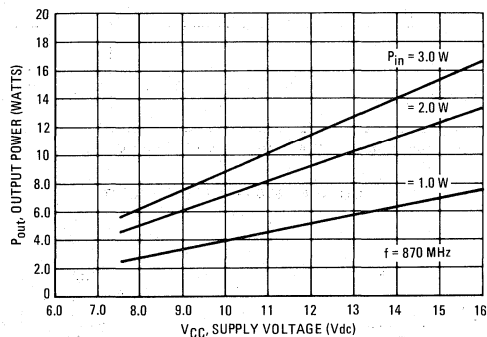
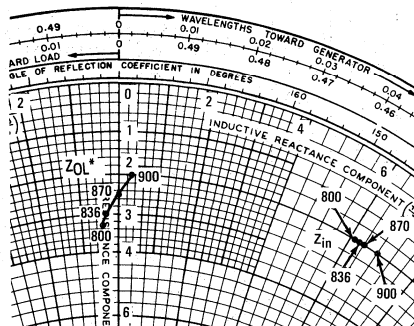


FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

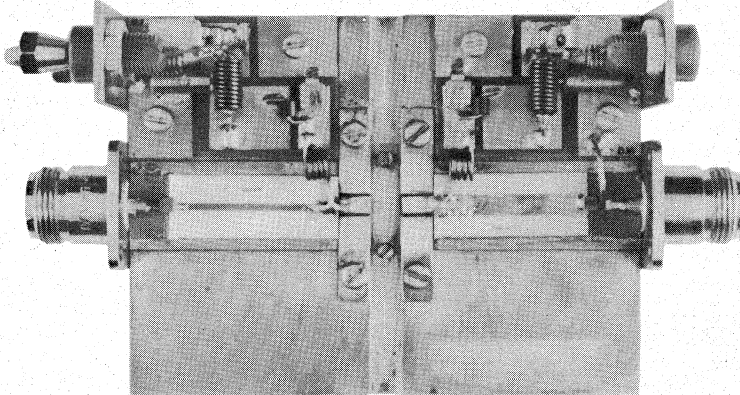


$P_{out} = 10 \text{ W}, V_{CC} = 12.5 \text{ Vdc}$

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
800	$2.0 + j6.1$	$3.3 - j0.4$
836	$2.0 + j6.2$	$3.0 - j0.3$
870	$2.0 + j6.4$	$2.5 + j0.0$
900	$2.0 + j6.8$	$2.0 + j0.3$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 – 870 MHz TEST CIRCUIT



The RF Line

NPN Silicon

RF Power Transistors

2

... designed primarily for wideband large-signal output and driver stages in the 806–960 MHz frequency range.

- Specified 12.5 Volt, 870 MHz Characteristics ($P_{out} = 5\text{ W}$
Common Base Gain = 10 dB (Typ)
Efficiency = 65% (Typ)
- Internally Matched Input for Broadband Operation
- Gold Metallized and Emitter Ballasted for Improved Reliability
- 100% Tested for Load Mismatch at Rated Input Power and 15.5 V

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	2	Adc
Total Device Dissipation ($T_C = 25^\circ\text{C}$ Derate Above 25°C)	P_D	25 143	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +150	$^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mAdc}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	10	—	150	—
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DYNAMIC CHARACTERISTICS

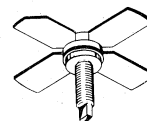
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	6	9.5	15	pF
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FUNCTIONAL TESTS ($f = 870\text{ MHz}$)

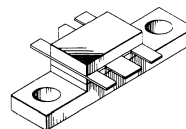
Common-Base Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 5\text{ W}$)	G_{PB}	8.5	10	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 5\text{ W}$)	η_c	—	65	—	%
Load Mismatch ($V_{CC} = 15.5\text{ Vdc}$, $P_{in} = 710\text{ mW}$, $V_{SWR} = 20:1$, all Phase Angles)	ψ	No Degradation in Output Power			

MRF841
MRF841F

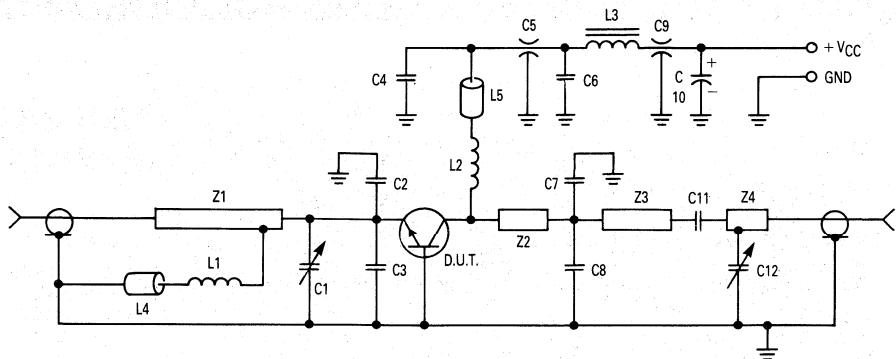
5 W 870 MHz
RF POWER
TRANSISTORS
NPN SILICON



MRF841
CASE 244-04, STYLE 4



MRF841F
CASE 319-06, STYLE 1



C1, C12 — 0.8–8 pF Johanson 7290 Variable
 C2 — 5 pF Mini-Underwood Mica
 C3 — 8.2 pF Mini-Underwood Mica
 C4 — 91 pF Mini-Underwood Mica
 C5, C9 — 680 pF Feedthru
 C6 — 0.1 μ F Ceramic
 C7, C8 — 10 pF Mini-Underwood Mica
 C10 — 1 μ F Electrolytic
 C11 — 43 pF Mini-Underwood

L1, L2 — 4 Turns, #22 AWG Wire, 0.2-inch ID
 L3 — VK200 Ferroxcube
 L4, L5 — Ferrite Bead, Ferroxcube #56-590-65-3B
 Z1 — 2.36" x 0.145" Microstrip 33 Ohm Line
 Z2 — 0.5" x 0.175" Microstrip 28 Ohm Line
 Z3 — 1.40" x 0.175" Microstrip 28 Ohm Line
 Z4 — 0.40" x 0.175" Microstrip 28 Ohm Line
 Board = 0.032" Glass Teflon 2 oz. cu clad $\epsilon_r = 2.55$

MRF841

Figure 1. 800–960 MHz Broadband Power Gain Test Circuit

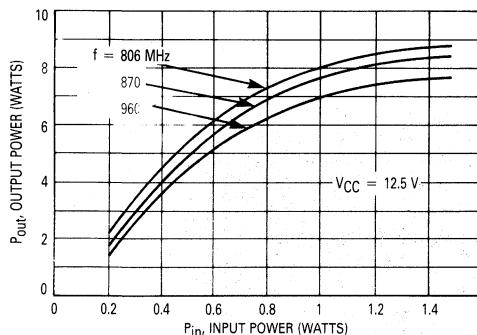


Figure 2. Output Power versus Input Power

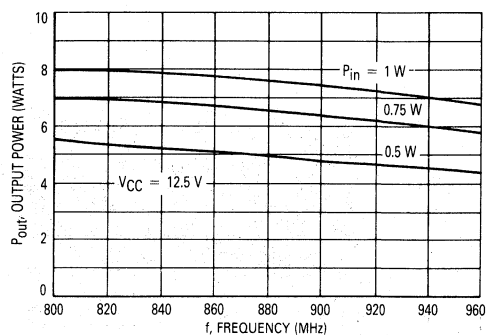


Figure 3. Output Power versus Frequency

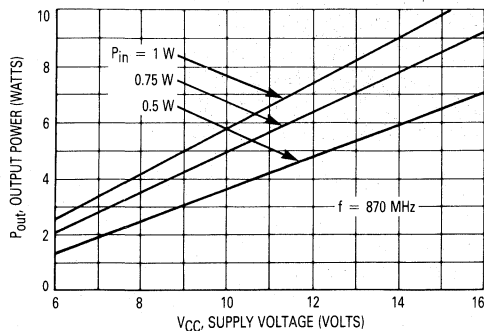


Figure 4. Power Out versus Supply Voltage

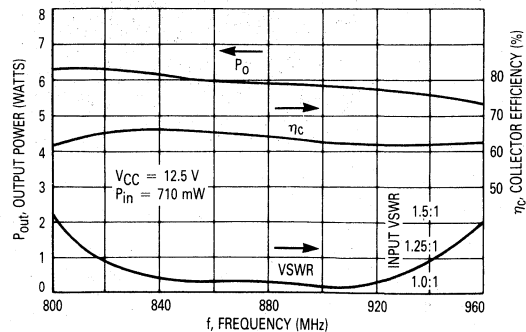


Figure 5. Typical Performance in Broadband Circuit

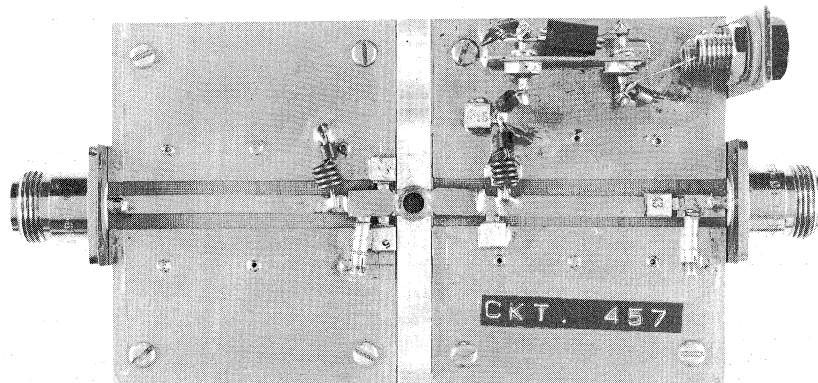


Figure 6. MRF841 Broadband Power Gain Test Circuit

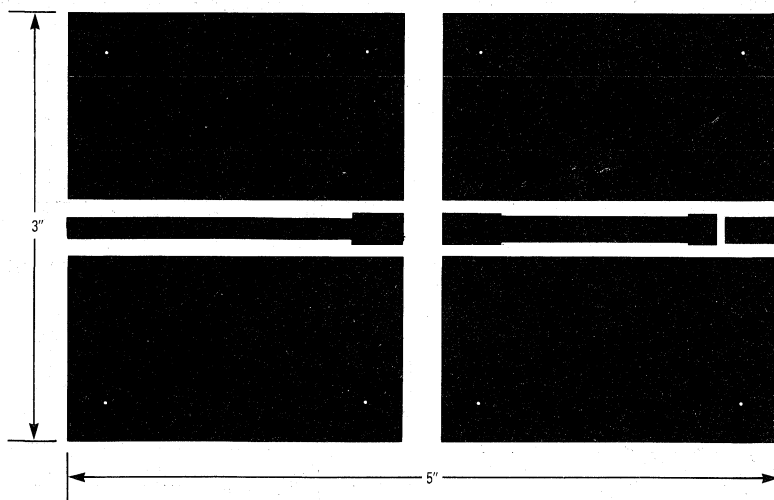


Figure 7. MRF841 Test Circuit Photomaster

NOTE: The Printed Circuit Board shown is 75% of the original.

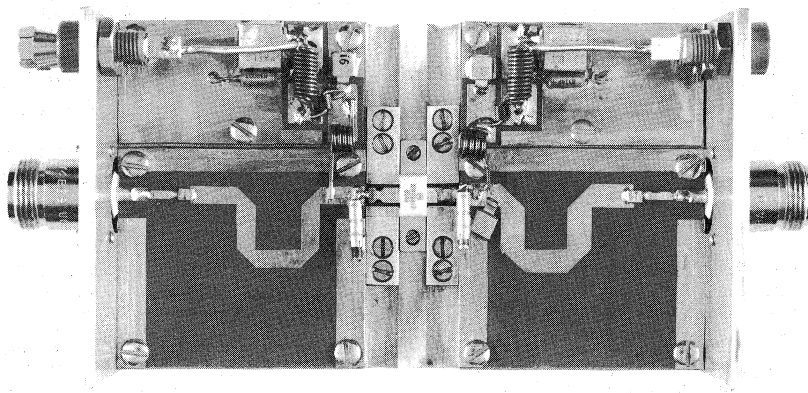


Figure 8. MRF841F Broadband Power Gain Test Circuit

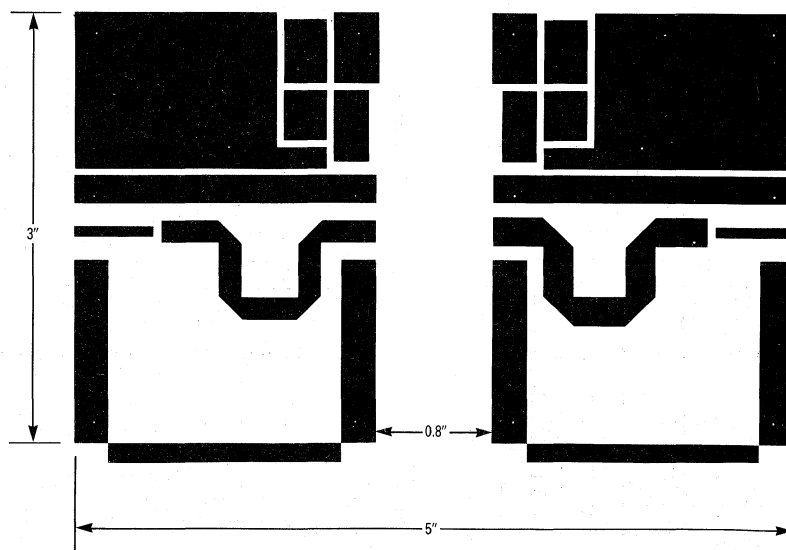
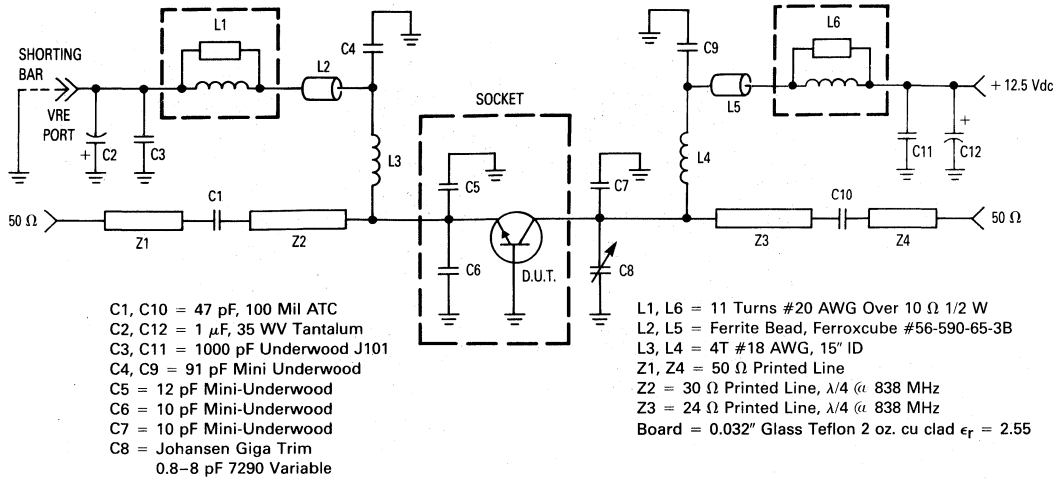


Figure 9. MRF841F Test Circuit Photomaster

NOTE: The Printed Circuit Board shown is 75% of the original.



NOTES: C7 and C8 mounted \approx 250 mils
 down Z3 from collector edge of board

MRF841F

Figure 10. 800-960 MHz Broadband Power Gain Test Circuit

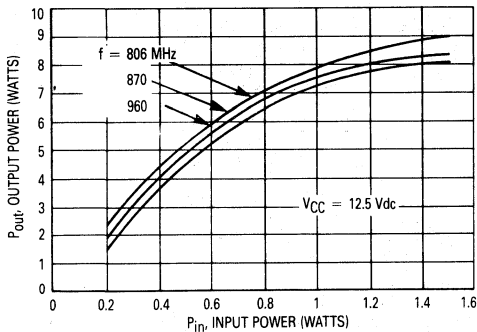


Figure 11. Output Power versus Input Power

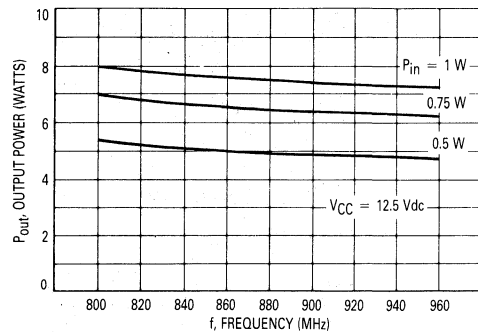


Figure 12. Output Power versus Frequency

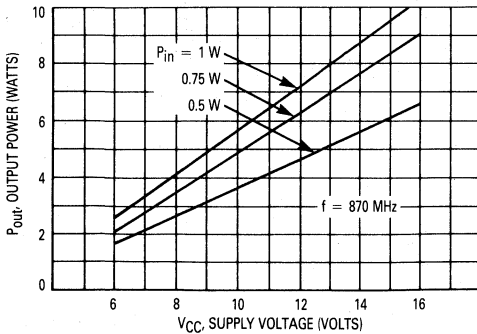


Figure 13. Output Power versus Supply Voltage

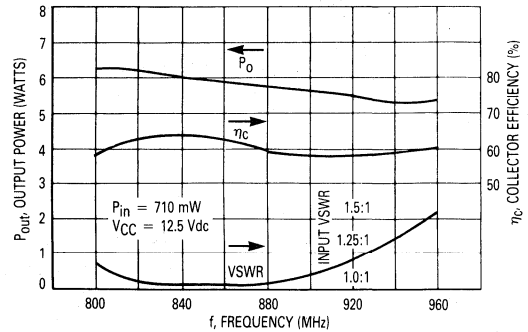


Figure 14. Typical Performance in Broadband Circuit

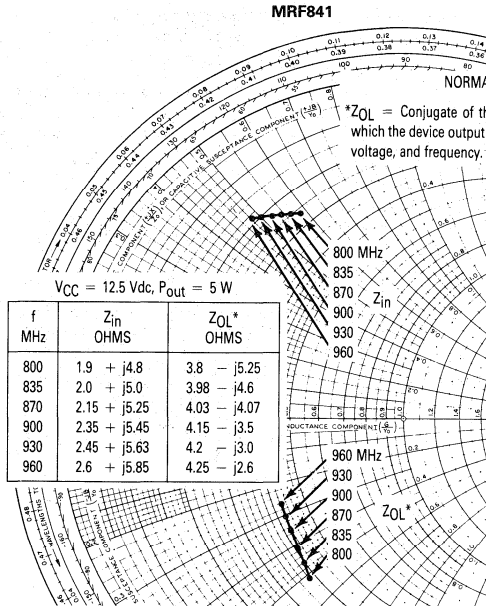


Figure 15. Series Equivalent Input/Output Impedances

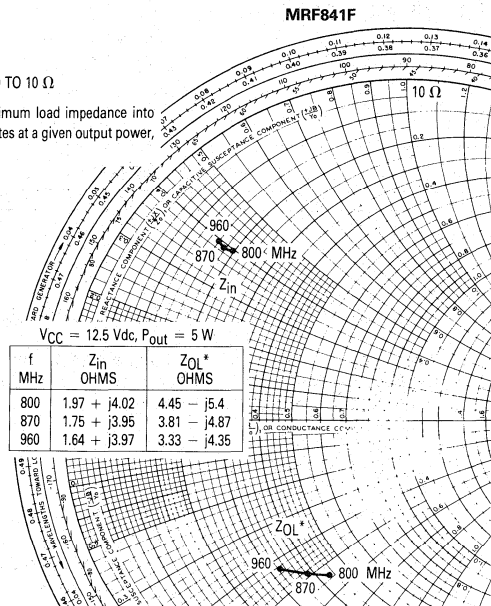


Figure 16. Series Equivalent Input/Output Impedances

The RF Line

NPN SILICON RF POWER TRANSISTOR

...designed for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806-960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
Output Power = 20 Watts
Minimum Gain = 6.0 dB
Efficiency = 50%
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- 100% Tested for Load Mismatch Stress at All Phase Angles with 20:1 VSWR @ 15.5 Volt Supply and 50% RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current - Continuous	I_C	7.6	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	80 0.64	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.5	$^\circ\text{C/W}$

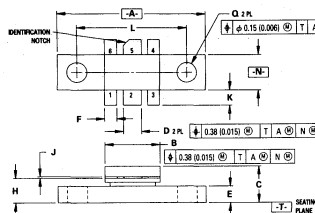
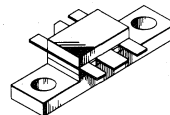
- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF842

20 W - 870 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:

- PIN 1. BASE (COMMON)
- 2. EMITTER (INPUT)
- 3. BASE (COMMON)
- 4. BASE (COMMON)
- 5. COLLECTOR (OUTPUT)
- 6. BASE (COMMON)

NOTES:

- 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- 2. CONTROLLING DIMENSION: INCH.

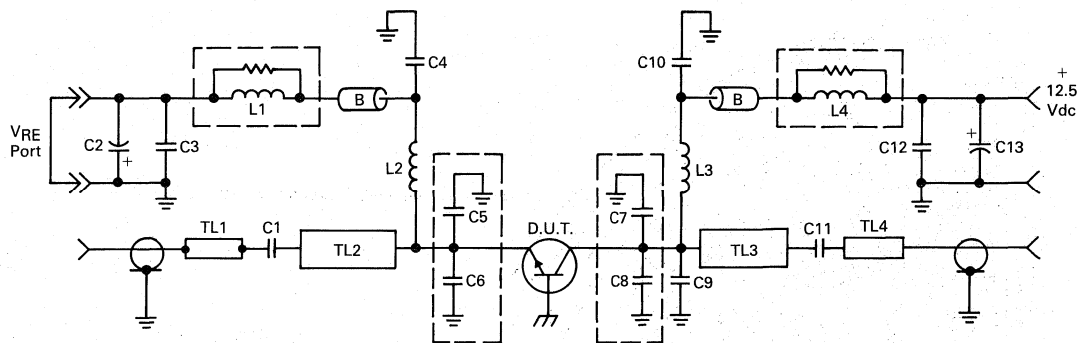
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	45	65	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain ($P_{out} = 20\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 870\text{ MHz}$)	G_{PB}	6.0	7.0	—	dB
Collector Efficiency ($P_{out} = 20\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 870\text{ MHz}$)	η	50	55	—	%
Load Mismatch Stress ($V_{CC} = 15.5\text{ Vdc}$, $P_{in}^* = 6.0\text{ W}$, $f = 870\text{ MHz}$, $VSWR = 20:1$, all phase angles)	—	No Degradation in Output Power			

* P_{in} = 150% of the typical input power requirement for 20 W output power @ 12.5 Vdc.

FIGURE 1 — 870 MHz TEST CIRCUIT SCHEMATIC

C1, C11 — 51 pF, 100 Mil Chip Capacitor
 C2, C13 — 15 μF , 20 WV Tantalum
 C3, C12 — 1000 pF Unelco J101
 C4, C10 — 91 pF Mini-Underwood
 C5 — 15 pF Mini-Underwood
 C6 — 12 pF Mini-Underwood
 C7, C8 — 21 pF Mini-Underwood
 C9 — 11 pF Mini-Underwood

L1, L4 — 11 Turns #20 AWG Over 10 ohm 1/2 W Carbon
 L2, L3 — 4 Turns #20 AWG, 200 Mil ID
 B — Ferrite Bead, Ferroxcube 56-590-65-3B
 TL1, TL4 — Micro Strip, $Z_0 = 50\ \Omega$
 TL2 — Micro Strip, $Z_0 = 38\ \Omega$, $\lambda/4$ @ 838 MHz
 TL3 — Micro Strip, $Z_0 = 24\ \Omega$, $\lambda/4$ @ 838 MHz
 Board — 0.032" Glass Teflon
 2 oz. Cu CLAD, $\epsilon_r = 2.55$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

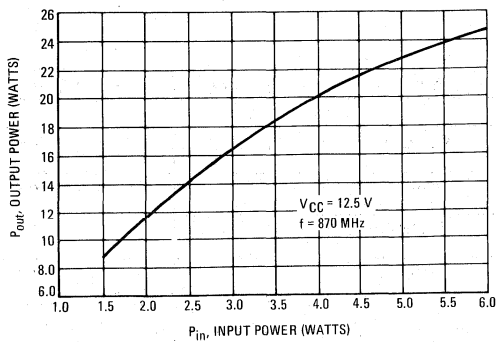


FIGURE 3 — OUTPUT POWER versus FREQUENCY

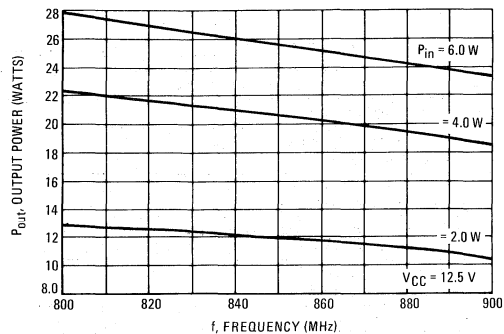


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

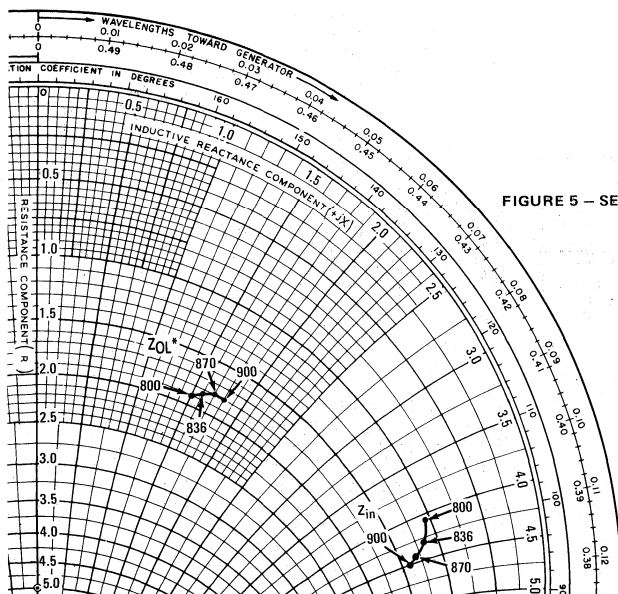
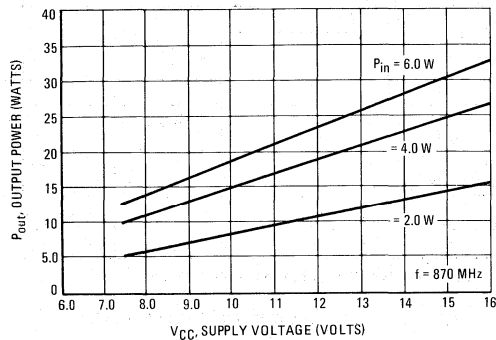


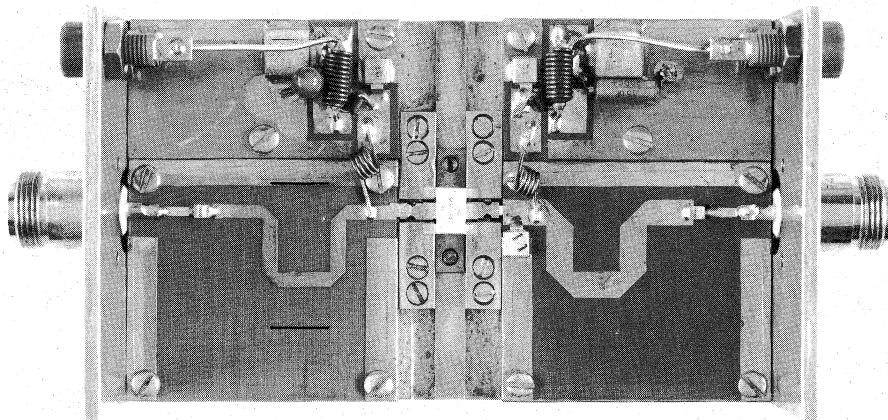
FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

$P_{out} = 20 \text{ W}$, $V_{CC} = 12.5 \text{ Vdc}$

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
800	$1.1 + j4.1$	$1.9 + j1.5$
836	$1.2 + j4.3$	$1.85 + j1.6$
870	$1.4 + j4.4$	$1.8 + j1.7$
900	$1.6 + j4.5$	$1.8 + j1.8$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 – 870 MHz TEST CIRCUIT



The RF Line **NPN Silicon** **RF Power Transistors**

... designed for 12.5 Volt UHF large-signal, **common-base** applications in industrial and commercial FM equipment operating in the range of 806-960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
 - Output Power = 15 Watts
 - Minimum Gain = 7 dB
 - Efficiency = 55%
- Internally Matched Input for Broadband Operation
- Gold Metallized and Emitter Ballasted for Long Life
- 100% Tested for Load Mismatch at 2 dB Overdrive and 15.5 V

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	16	V _{dc}
Collector-Base Voltage	V _{CBO}	36	V _{dc}
Emitter-Base Voltage	V _{EBO}	4	V _{dc}
Collector-Current — Continuous	I _C	4	A _{dc}
Operating Junction Temperature	T _J	200	°C
Total Device Dissipation @ T _A = 25°C Derate above 25°C	P _D	44 0.25	Watts W/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	R _{θJC}	4	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (I _C = 25 mA _{dc} , I _B = 0)	V _{(BR)CEO}	16	—	—	V _{dc}
Collector-Emitter Breakdown Voltage (I _C = 25 mA _{dc} , V _{BE} = 0)	V _{(BR)CES}	36	—	—	V _{dc}
Emitter-Base Breakdown Voltage (I _E = 5 mA _{dc} , I _C = 0)	V _{(BR)EBO}	4	—	—	V _{dc}
Collector Cutoff Current (V _{CE} = 15 V _{dc} , V _{BE} = 0, T _C = 25°C)	I _{CES}	—	—	5	mA _{dc}

ON CHARACTERISTICS

DC Current Gain (I _C = 1 A _{dc} , V _{CE} = 5 V _{dc})	h _{FE}	10	—	120	—
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DYNAMIC CHARACTERISTICS

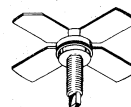
Output Capacitance (V _{CB} = 15 V _{dc} , I _E = 0, f = 1 MHz)	C _{ob}	—	30	45	pF
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FUNCTIONAL TESTS

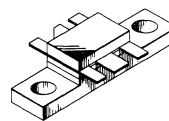
Common Base Amplifier Power Gain (V _{CC} = 12.5 V _{dc} , P _{out} = 15 W, f = 870 MHz)	G _{pb}	7	7.9	—	dB
Collector Efficiency (V _{CC} = 12.5 V _{dc} , P _{out} = 15 W, f = 870 MHz)	η	55	60	—	%
Load Mismatch Stress (P _{in} = 2 dB Overdrive, V _{CC} = 15.5 V, f = 870 MHz, VSWR = 20:1 @ All Phase Angles)	ψ	No Degradation in Output Power			

MRF843
MRF843F

15 W 806-960 MHz
RF POWER
TRANSISTORS
COMMON BASE
NPN SILICON



CASE 244-04, STYLE 4
 MRF843



CASE 319-06, STYLE 1
 MRF843F

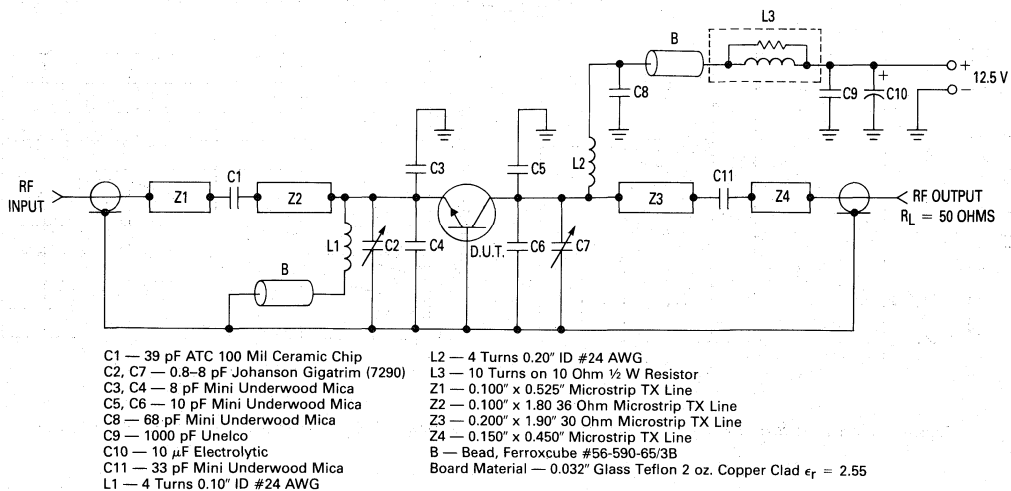


Figure 1. MRF843 800–900 MHz Broadband Test Fixture

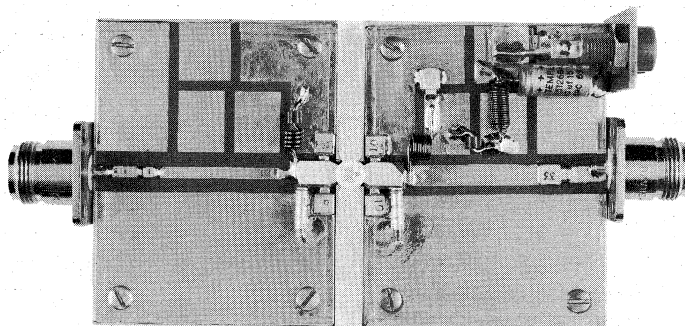


Figure 2. MRF843 800–900 MHz Test Circuit

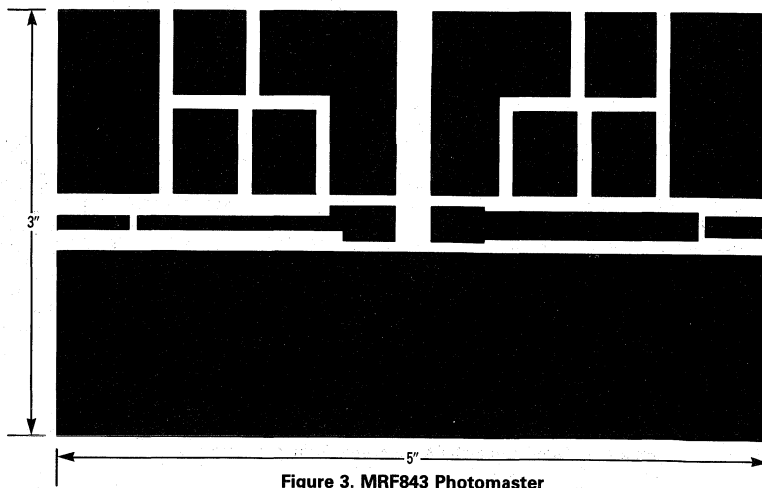


Figure 3. MRF843 Photomaster

NOTE: The Printed Circuit Board shown is 75% of the original.

MRF843

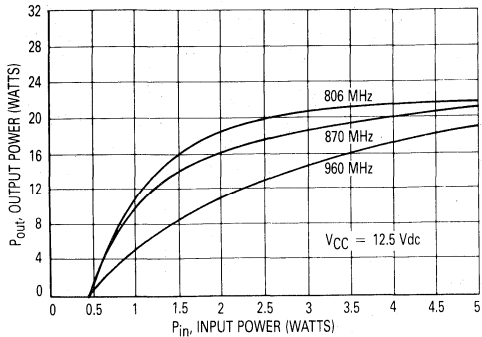


Figure 4. Output Power versus Input Power

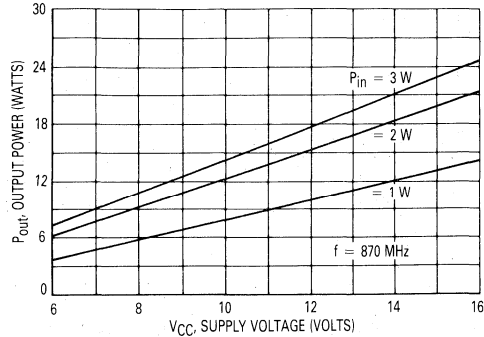


Figure 5. Output Power versus Supply Voltage

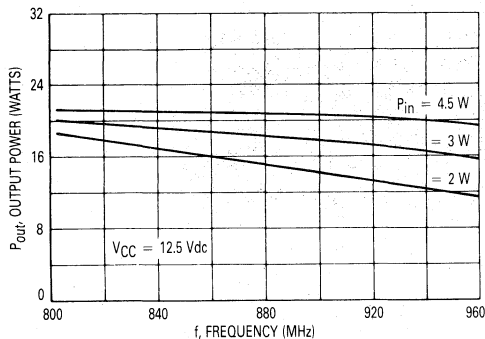


Figure 6. Output Power versus Frequency

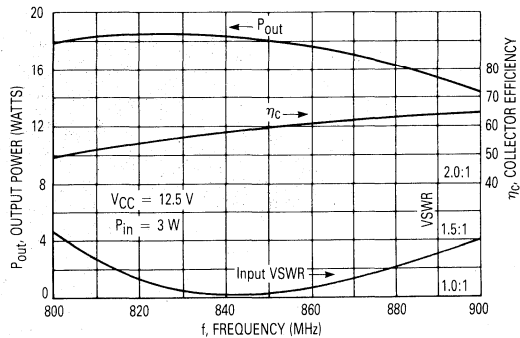


Figure 7. Typical Performance in Broadband Test Fixture

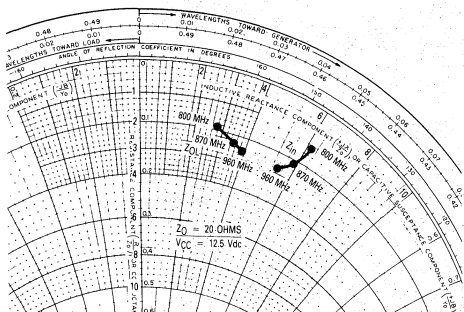


Figure 8. Series Equivalent Input and Output Impedance

f MHz	Z _{in} Ohms	Z _{OL} * Ohms
800	1.23 + j 6.13	1.98 + j 2.62
870	2.09 + j 5.91	2.24 + j 3.49
960	2.58 + j 5.46	2.51 + j 3.92

NOTE: Circuit tuning and input power adjusted to maintain output power of 15 W and 65% efficiency.

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

MRF843F

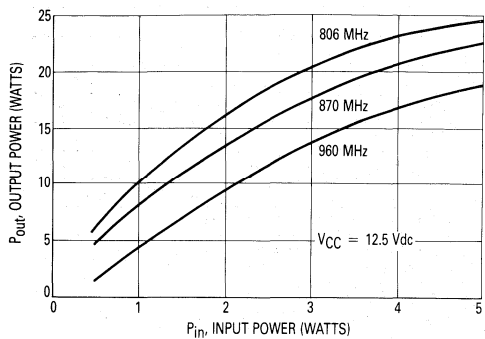


Figure 9. Output Power versus Input Power

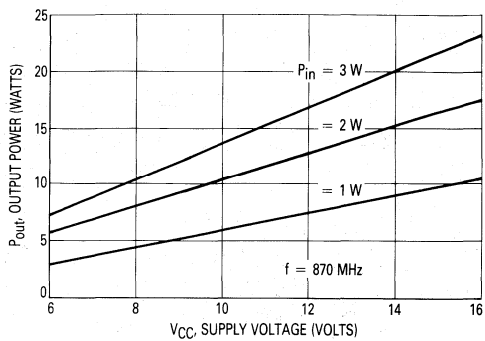


Figure 10. Output Power versus Supply Voltage

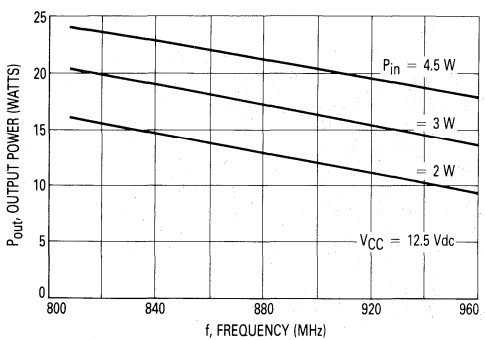


Figure 11. Output Power versus Frequency

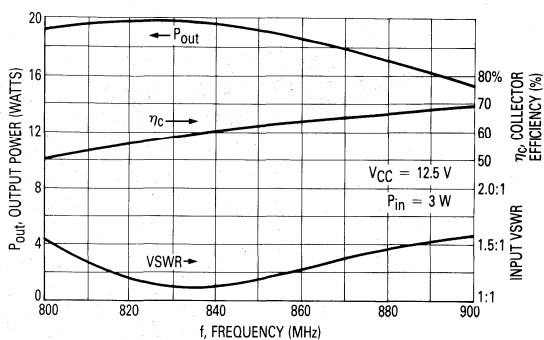


Figure 12. Typical Performance in Broadband Test Fixture

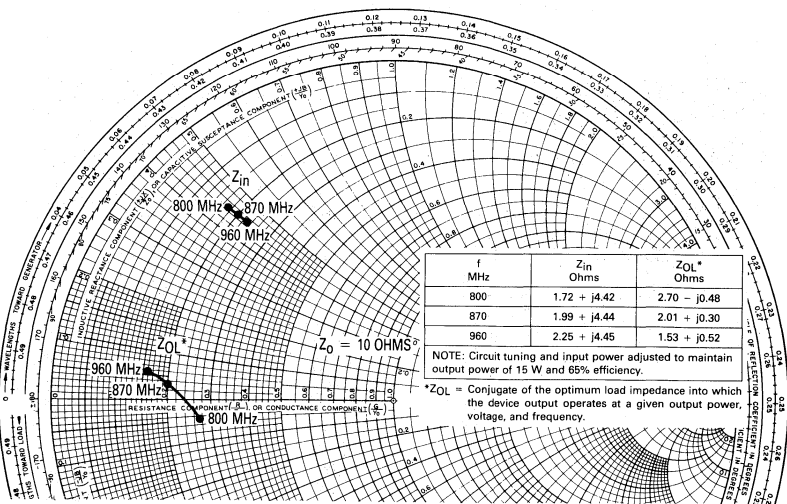


Figure 13. Series Equivalent Input and Output Impedance

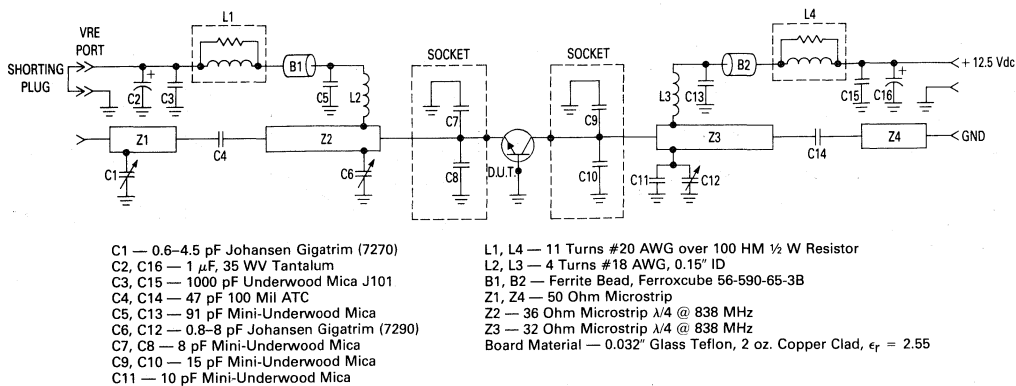


Figure 14. MRF843F 800–900 MHz Broadband Test Circuit

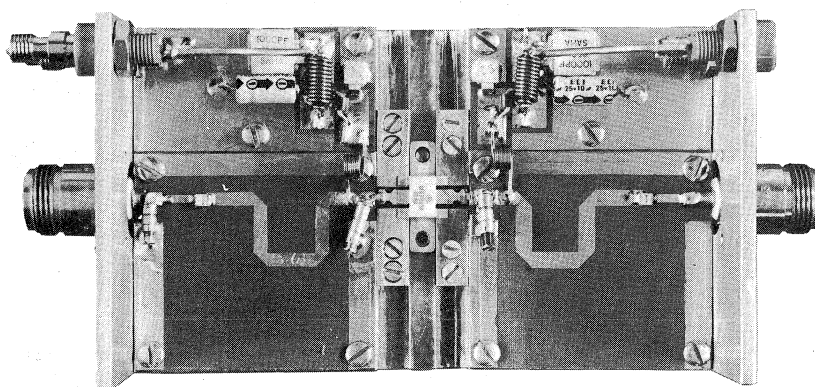


Figure 15. MRF843F Broadband Test Circuit

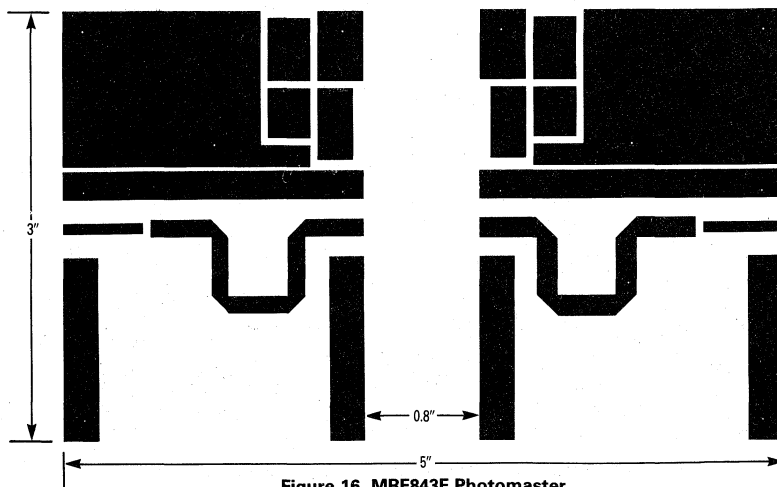


Figure 16. MRF843F Photomaster

NOTE: The Printed Circuit Board shown is 75% of the original.

MRF844

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
Output Power = 30 Watts
Minimum Gain = 5.2 dB
Efficiency = 50%
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at All Phase Angles with 20:1 VSWR @ High Line and RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	10.9	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1)	P_D	115	Watts
Derate Above 25°C		0.66	W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

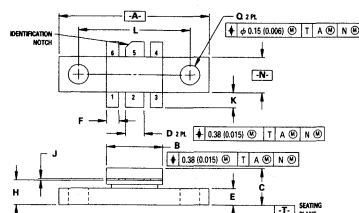
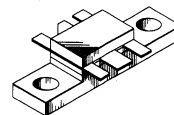
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.5	$^\circ\text{C/W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

30 W-870 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:

- PIN 1: BASE (COMMON)
2: EMITTER (INPUT)
3: BASE (COMMON)
4: BASE (COMMON)
5: COLLECTOR (OUTPUT)
6: BASE (COMMON)

NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	40	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	60	90	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain ($P_{out} = 30\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 870\text{ MHz}$)	G_{PB}	5.2	6.0	—	dB
Collector Efficiency ($P_{out} = 30\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 870\text{ MHz}$)	η	50	55	—	%
Load Mismatch Stress ($V_{CC} = 15.5\text{ Vdc}$, $P_{in} = 12\text{ W}^*$, $f = 870\text{ MHz}$, $VSWR = 20:1$, all phase angles)	—	No Degradation in Output Power			

* P_{in} = 150% of the typical input power requirement for 30 W output power @ 12.5 Vdc.

FIGURE 1 — 870 MHz TEST CIRCUIT

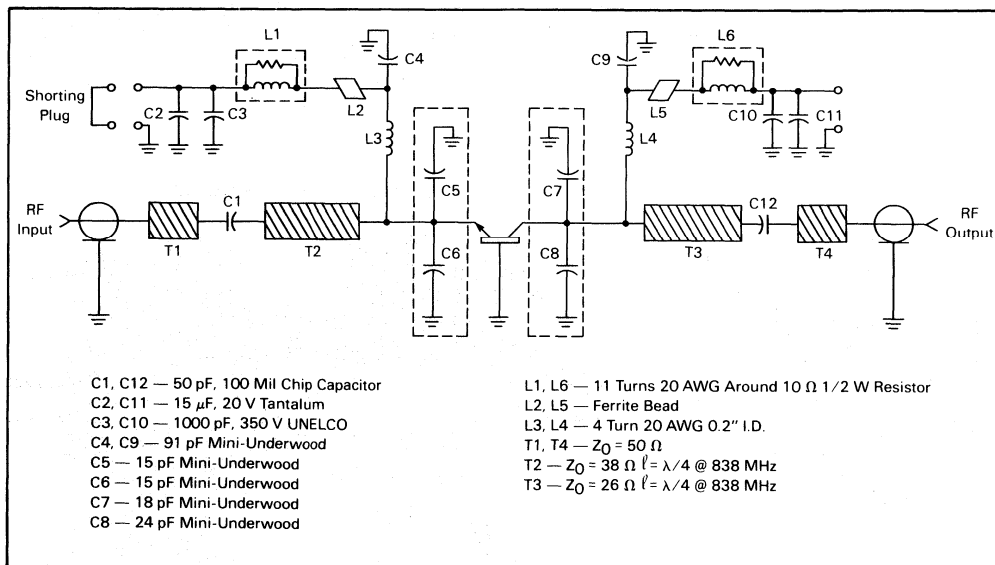


FIGURE 2 — OUTPUT POWER versus INPUT POWER

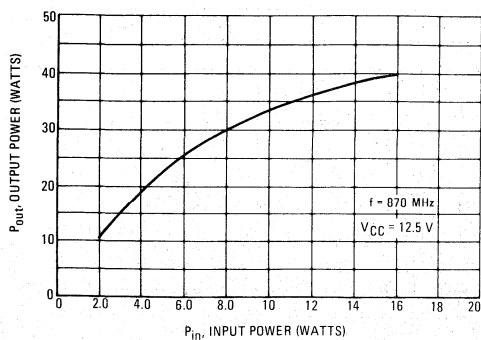


FIGURE 3 — OUTPUT POWER versus FREQUENCY

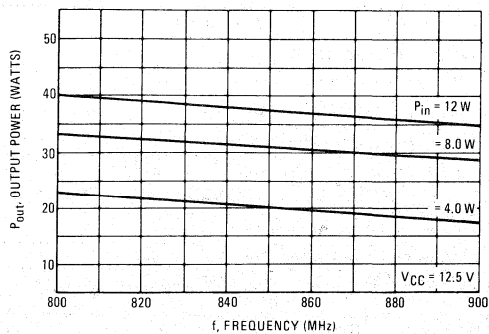


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

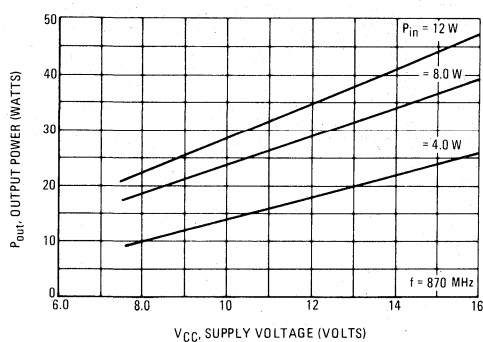


FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

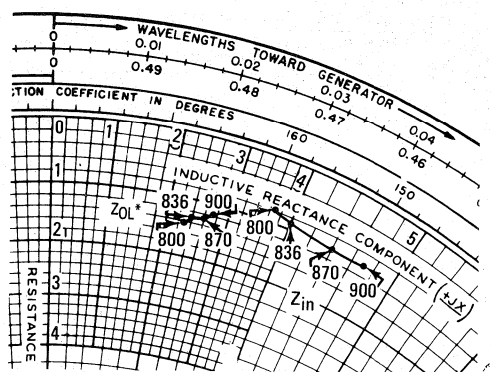
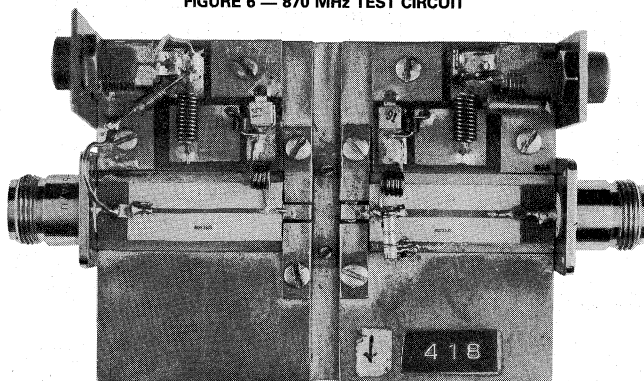


FIGURE 6 — 870 MHz TEST CIRCUIT



$P_{in} = 7.5 \text{ W}$, $P_{out} = 30 \text{ W}$, $V_{CC} = 12.5 \text{ Vdc}$

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
800	$0.8 + j3.7$	$1.4 + j2.3$
836	$0.9 + j4.0$	$1.3 + j2.4$
870	$1.0 + j4.4$	$1.25 + j2.6$
900	$1.0 + j4.7$	$1.2 + j2.7$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806-960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
 - Output Power = 40 Watts
 - Minimum Gain = 4.3 dB
 - Efficiency = 50%
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at All Phase Angles with 10:1 VSWR @ High Line and RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	14.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	150 0.86	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.17	$^\circ\text{C/W}$

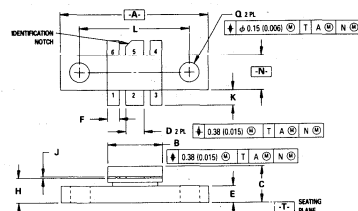
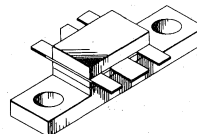
- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF846

40 W-870 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:

- PIN 1: BASE (COMMON)
- 2: EMITTER (INPUT)
- 3: BASE (COMMON)
- 4: BASE (COMMON)
- 5: COLLECTOR (OUTPUT)
- 6: BASE (COMMON)

NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.

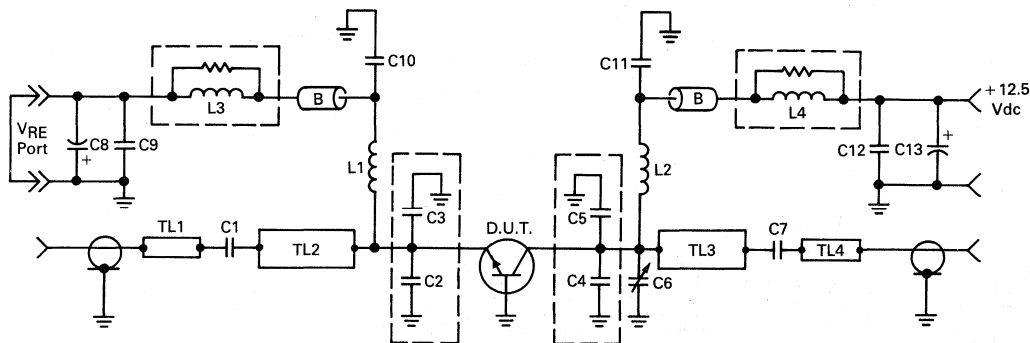
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42	BSC	0.725	BSC
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	50	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	85	120	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain ($P_{out} = 40\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 870\text{ MHz}$)	G_{PB}	4.3	5.2	—	dB
Collector Efficiency ($P_{out} = 40\text{ W}$, $V_{CC} = 12.5\text{ Vdc}$, $f = 870\text{ MHz}$)	η	50	55	—	%
Load Mismatch Stress ($V_{CC} = 15.5\text{ Vdc}$, $P_{in} = 15\text{ W}$, $f = 870\text{ MHz}$, $VSWR = 10:1$, all phase angles)	—	No Degradation in Output Power			

* P_{in} = 125% of the typical input power requirement for 40 W output power @ 12.5 Vdc.

FIGURE 1 — 870 MHz TEST CIRCUIT SCHEMATIC

C1 — 43 pF, 100 Mil Chip Capacitor
 C2 — 12 pF Mini-Unelco
 C3 — 15 pF Mini-Unelco
 C4 — 21 pF Mini-Unelco
 C5 — 18 pF Mini-Unelco
 C6 — 0.8–8.0 pF Johanson Gigatrim
 C7 — 47 pF, 100 Mil Chip Capacitor
 C8 — 10 μF , 25 WV
 C9, C12 — 1000 pF Unelco J101
 C10, C11 — 91 pF Mini-Unelco
 C13 — 25 μF , 25 WV

L1, L2 — 4 Turns #18 Enameled; 200 Mil ID
 L3, L4 — 15 Turns #24 Enameled Over 12 ohm Carbon Resistor
 B — Ferrite Bead; Ferroxcube 56-590-65-3B
 TL1, TL4 — Micro Strip; 50 Ω
 TL2 — Micro Strip; $Z_0 = 34\ \Omega$, $\lambda/4$ @ 838 MHz
 TL3 — Micro Strip; $Z_0 = 30\ \Omega$, $\lambda/4$ @ 838 MHz
 Board — 0.032" Glass Teflon
 2 oz. Cu CLAD, $\epsilon_r = 2.55$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

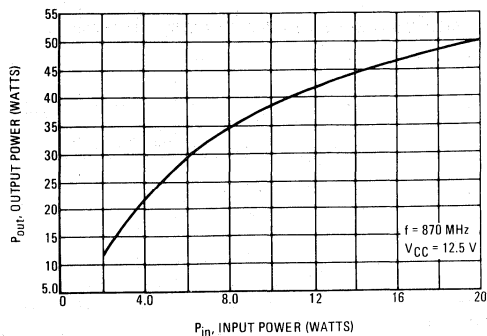


FIGURE 3 — OUTPUT POWER versus FREQUENCY

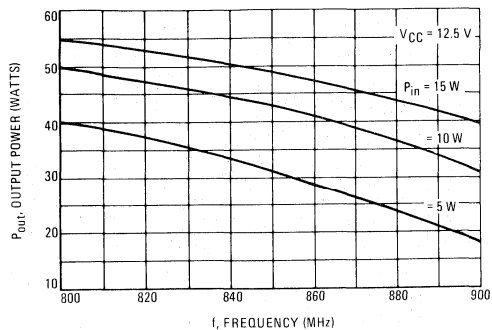


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

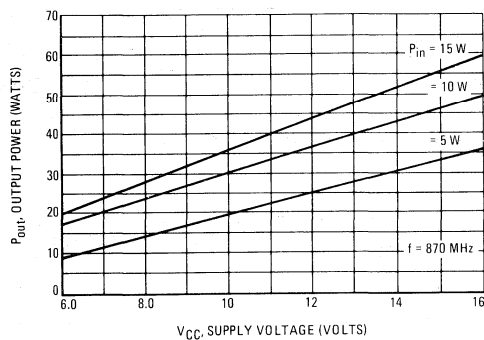
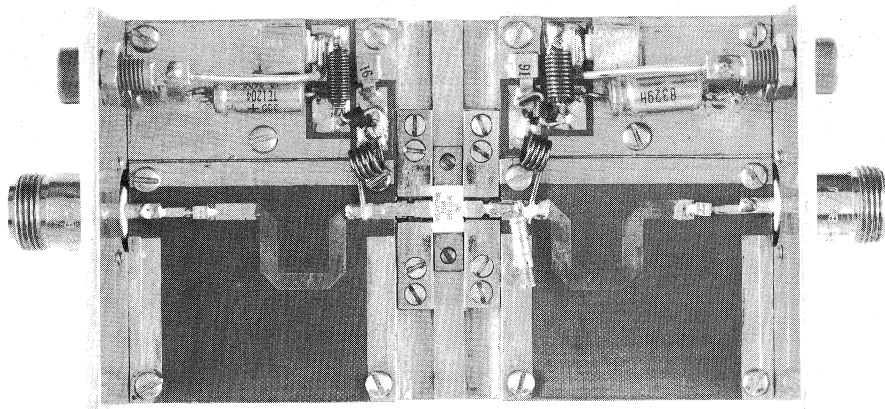


FIGURE 5 — 870 MHz TEST CIRCUIT



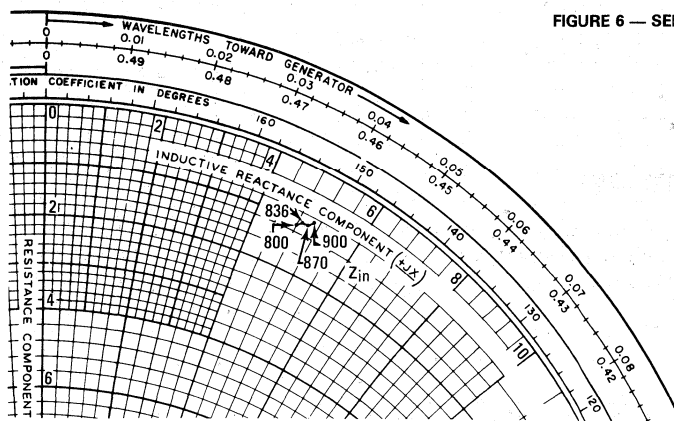


FIGURE 6 — SERIES EQUIVALENT INPUT IMPEDANCES

 $V_{CC} = 12.5 \text{ Vdc}, P_{in} = 12 \text{ W}$

f MHz	Z_{in} Ohms
800	$1.1 + j4.8$
836	$1.0 + j4.9$
870	$1.0 + j5.0$
900	$0.9 + j5.1$

2

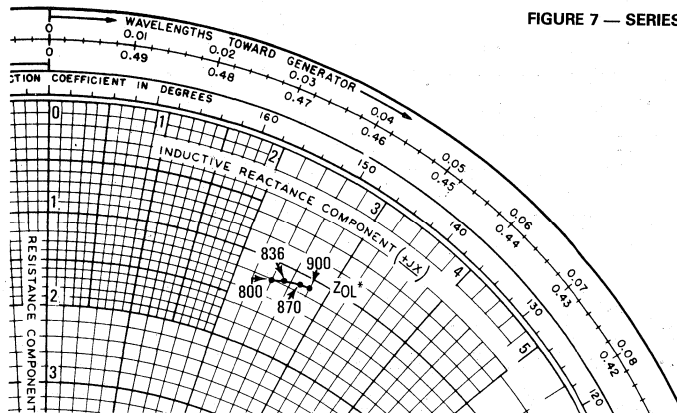


FIGURE 7 — SERIES EQUIVALENT OUTPUT IMPEDANCES

 $V_{CC} = 12.5 \text{ Vdc}, P_{out} = 40 \text{ W}$

f MHz	Z_{OL}^* Ohms
800	$1.2 + j2.4$
836	$1.15 + j2.5$
870	$1.1 + j2.7$
900	$1.1 + j2.8$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

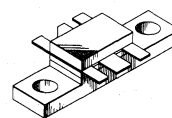
The RF Line
NPN Silicon
RF Power Transistor

MRF847

45 WATTS, 870 MHz
RF POWER
TRANSISTOR
NPN SILICON

... designed for 12.5 volt UHF large-signal **common-base** amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
 Output Power = 45 Watts
 Minimum Gain = 4.5 dB
 Efficiency = 60%
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 10:1 VSWR @ High Line and Rated Drive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated



CASE 319-06

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Base Voltage	V_{CBO}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	12	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	150 0.85	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +150	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.17	$^\circ\text{C}/\text{W}$
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ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Emitter-Base Breakdown Voltage ($I_E = 5 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	38	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15 \text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 2 \text{ Adc}$, $V_{CE} = 5 \text{ Vdc}$)	h_{FE}	40	65	120	—
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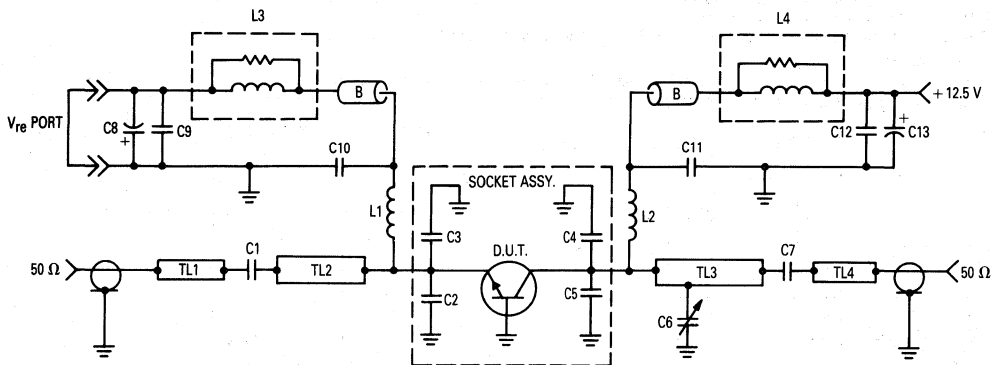
DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 12.5 \text{ Vdc}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	75	90	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 45\text{ W}$, $f = 870\text{ MHz}$)	G_{PB}	4.5	5.5	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 45\text{ W}$, $f = 870\text{ MHz}$)	η_c	60	68	—	%
Load Mismatch ($V_{CC} = 15.5\text{ Vdc}$, $P_{in} = 16\text{ W}$, $f = 870\text{ MHz}$, $VSWR = 10:1$ All Phase Angles)	ψ	No Degradation In Output Power			



C1 = 51 pF, 100 mil Chip Capacitor
 C2 = 12 pF, Mini-Underwood
 C3 = 11 pF, Mini-Underwood
 C4, C5 = 21 pF, Mini-Underwood
 C6 = 0.08–8.0 pF Johansen Gigatrim
 C7 = 47 pF, 100 mil Chip Capacitor
 C8, C13 = 10 μF , 25 WV Electrolytic Capacitor
 C9, C12 = 1000 pF Unelco J101

C10, C11 = 91 pF Mini-Underwood
 L1, L2 = 4 Turns #18 Enameled, 200 mil ID
 L3, L4 = 12 Turns #22 Enameled, Wound Over 10 Ω Resistor
 TL1, TL4 = 50 Ω Microstrip Line
 TL2 = Microstrip ($Z_0 = 38\text{ ohms}$, $\lambda/4$ @ 838 MHz)
 TL3 = Microstrip ($Z_0 = 28\text{ ohms}$, $\lambda/4$ @ 838 MHz)
 Board Material = 0.032" Glass-Teflon, 2 oz. cu. clad, $\epsilon_r = 2.56$
 B = Ferrite Bead, Ferroxcube 56-590-65-3B

Figure 1. 806–870 MHz Broadband Test Circuit

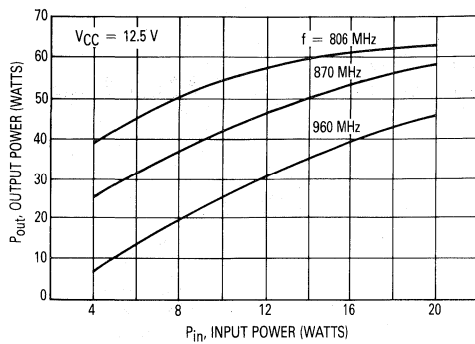


Figure 2. Output Power versus Input Power

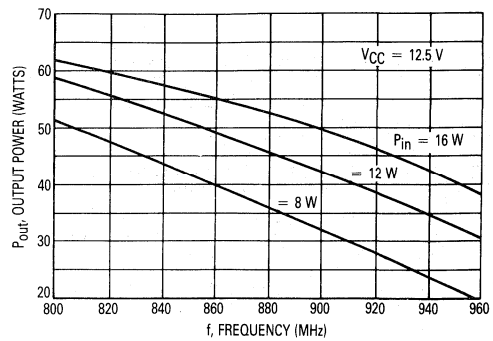


Figure 3. Output Power versus Frequency

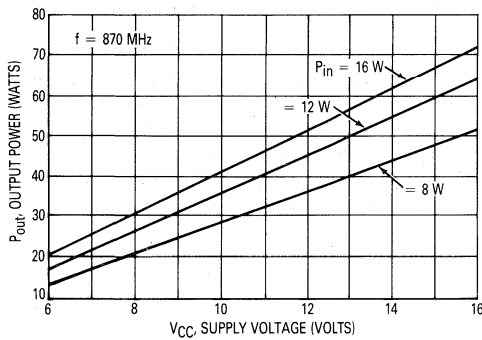


Figure 4. Output Power versus Supply Voltage

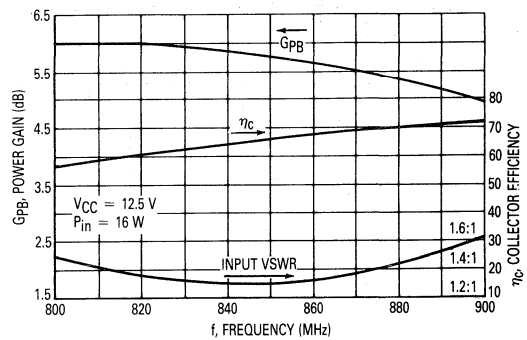


Figure 5. Typical Broadband Circuit Performance

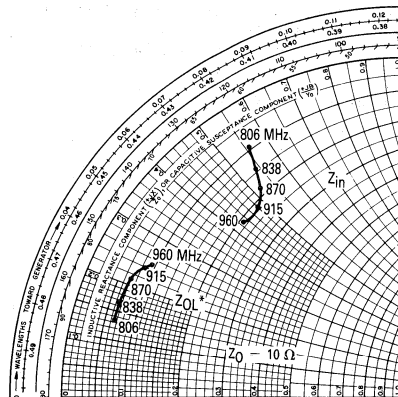


Figure 6. Series Equivalent Input/Output Impedances

$V_{CC} = 12.5 \text{ Vdc}$, $P_{in} = 16 \text{ W}$, $P_{out} = 45 \text{ W}$

f MHz	Z_{in} (Ohms)	f MHz	Z_{OL}^* (Ohms)
806	0.99 + j5.52	806	0.67 + j1.33
838	1.48 + j5.47	838	0.68 + j1.66
870	1.79 + j5.25	870	0.72 + j2.16
915	2.12 + j4.80	915	0.83 + j2.40
960	2.11 + j4.28	960	0.99 + j2.50

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

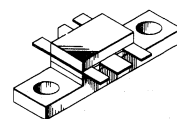
The RF Line
NPN Silicon
RF Power Transistor

... designed for 12.5 Volt UHF large-signal, **common-emitter** applications in industrial and commercial FM equipment operating in the range of 806-960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
Output Power = 15 Watts
Minimum Gain = 7 dB
Efficiency = 60%
- Internally Matched Input for Broadband Operation
- Series Equivalent Large-Signal Characterization
- Capable of withstanding 20:1 VSWR Load Mismatch at Rated Input Power and 15.5 Vdc
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

MRF873

15 W 806-960 MHz
RF POWER
TRANSISTOR
COMMON-EMITTER
NPN SILICON



CASE 319-06, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Emitter Voltage	V_{CES}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	2.4	Adc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	44 0.25	Watts W/°C
Storage Temperature Range	T_{stg}	- 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	4	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	38	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ Adc, $V_{CE} = 5$ Vdc)	h_{FE}	40	—	200	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 12.5$ Vdc, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	19.5	25	pF
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(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (Broadband) ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 870\text{ MHz}$)	G_{pe}	7	8	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 870\text{ MHz}$)	η	60	69	—	%
Load Mismatch Stress ($V_{CC} = 15.5\text{ Vdc}$, $f = 870\text{ MHz}$, $P_{in} = 3\text{ W}$, $VSWR = 20:1$, all phase angles)	ψ	No degradation in output power			

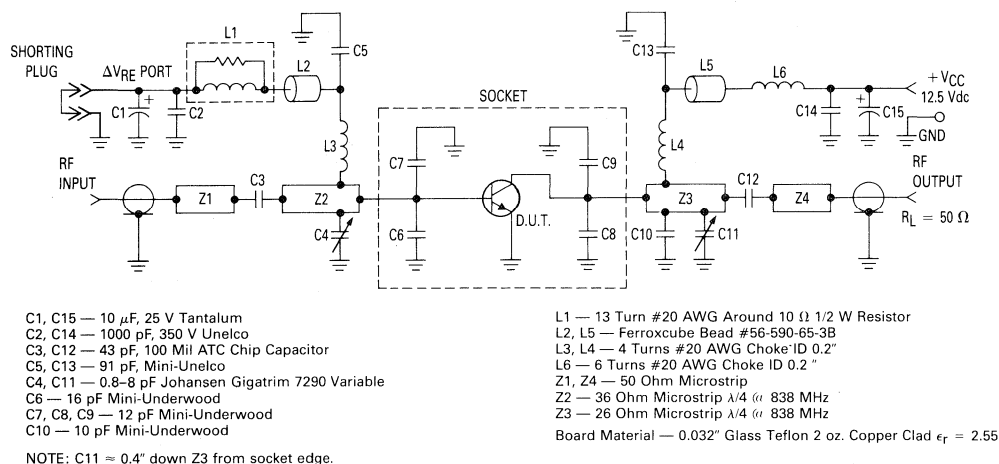


Figure 1. 806–900 MHz Broadband Test Fixture

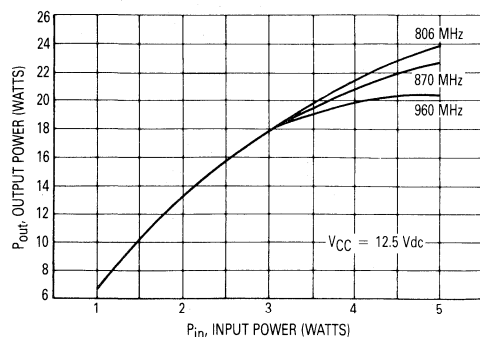


Figure 2. Output Power versus Input Power

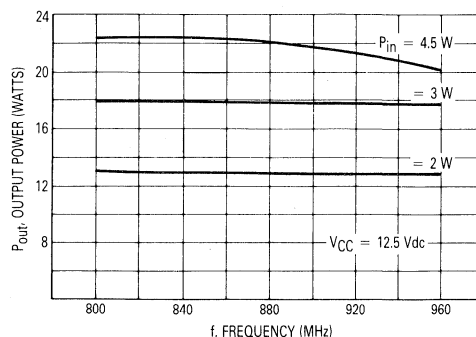


Figure 3. Output Power versus Frequency

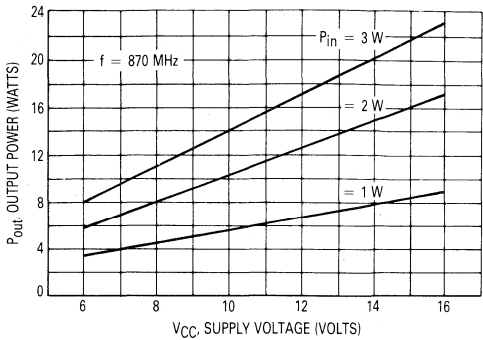


Figure 4. Output Power versus Supply Voltage

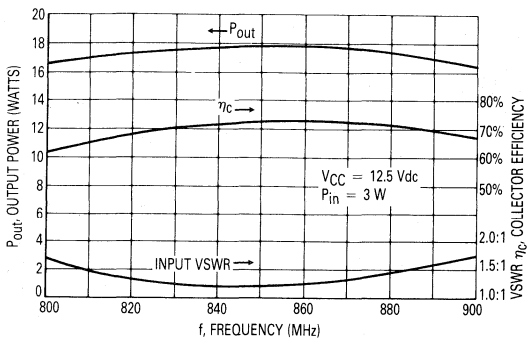


Figure 5. Typical Performance in Broadband Test Fixture

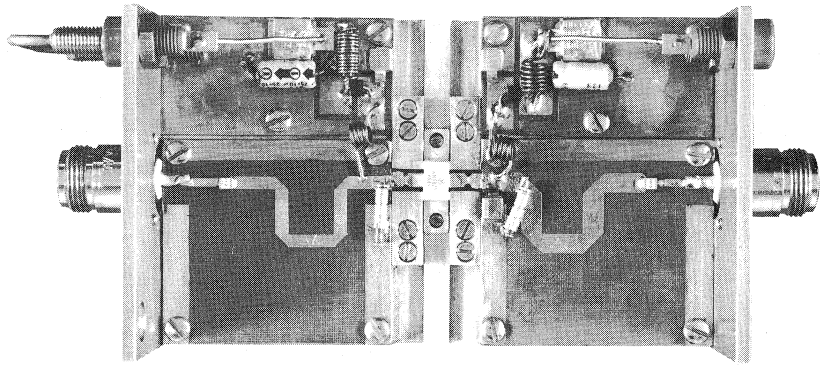


Figure 6. Photo Test Circuit

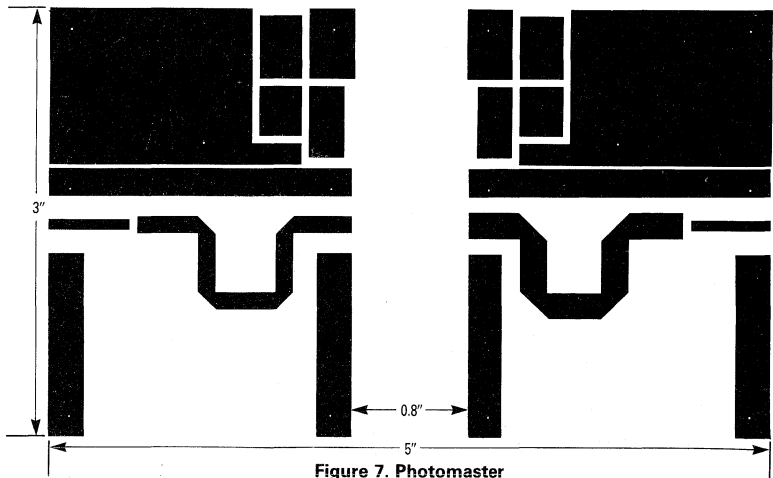


Figure 7. Photomaster

NOTE: The Printed Circuit Board shown is 75% of the original.

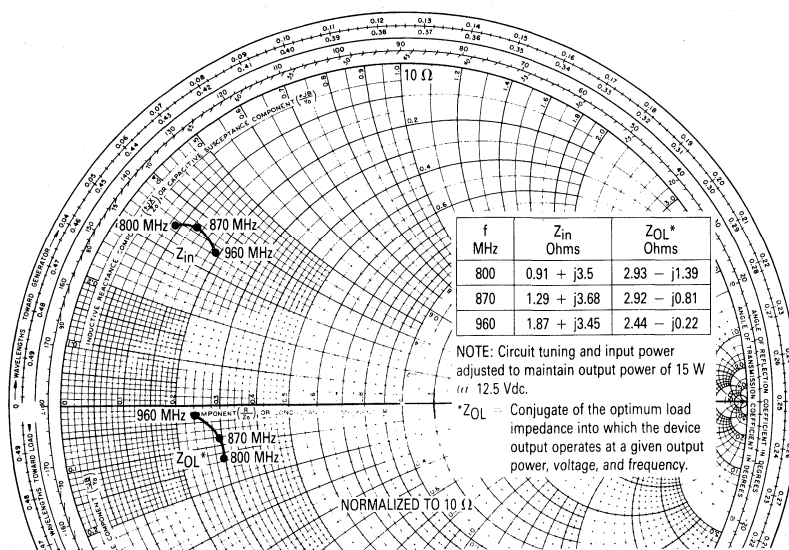


Figure 8. Series Equivalent Input/Output Impedances

MRF890

The RF Line

NPN SILICON RF POWER TRANSISTOR

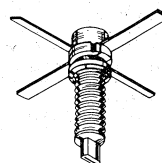
... designed for 24 volt UHF large-signal, common-emitter amplifier applications in industrial and commercial FM equipment operating in the range of 804 - 960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
Output Power = 2.0 Watts
Minimum Gain = 9.0 dB
Efficiency = 55%
- Series Equivalent Large-Signal Characterization
- Capable of 30:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

2.0 W 900 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



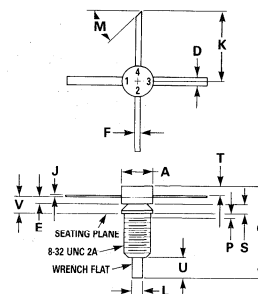
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	7.0 40	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

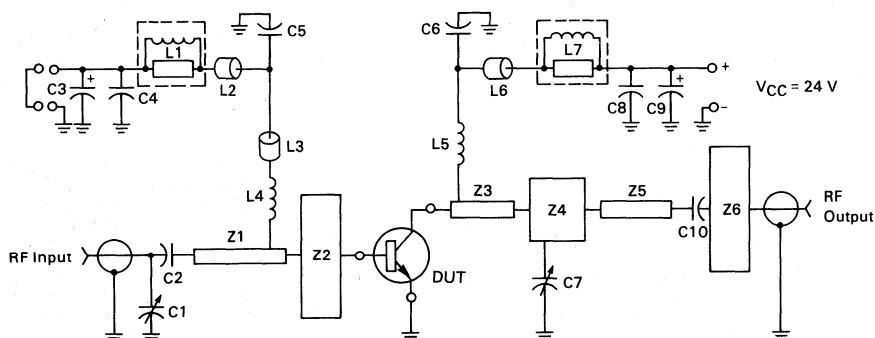
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.59	0.200	0.220
B	13.97	16.26	0.550	0.640
C	1.40	1.65	0.055	0.065
D	1.02	1.27	0.040	0.050
E	0.64	0.89	0.025	0.035
F	0.08	0.18	0.003	0.007
G	11.06	—	0.436	—
H	1.40	1.65	0.055	0.065
I	45° NOM		45° NOM	
J	—	1.27	—	0.050
K	1.40	1.65	0.055	0.065
L	1.40	1.78	0.055	0.070
M	2.79	3.81	0.110	0.150
N	2.41	2.92	0.095	0.115

CASE 305-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	2.0	—	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain ($P_{out} = 2.0\text{ W}$, $V_{CC} = 24\text{ Vdc}$, $f = 900\text{ MHz}$)	G_{PE}	9.0	10.5	—	dB
Collector Efficiency ($P_{out} = 2.0\text{ W}$, $V_{CC} = 24\text{ Vdc}$, $f = 900\text{ MHz}$)	η	55	60	—	%

FIGURE 1 — 850 - 900 MHz TEST CIRCUIT



- C1, C7 — Johanson 0.5 – 4.0 pF Giga-Trim
 C2, C5, C6 — 91 pF Mini Underwood Mica
 C3, C9 — 1.0 μF Electrolytic
 C4, C8 — 250 pF Unelco
 C10 — 39 pF Mini Underwood
 L1, L7 — 10 Turns Around 10 Ω 1/2 W Resistor
 L2, L3, L6 — Ferrite Bead
 L4, L5 — 4 Turns 26 AWG 0.1" ID
 Z1, Z2, Z3, Z4, Z5, Z6 — Distributed Microstrip Elements (see photomask)
 Board Material — Glass Teflon $\epsilon_r = 2.55$ $t = 0.031"$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

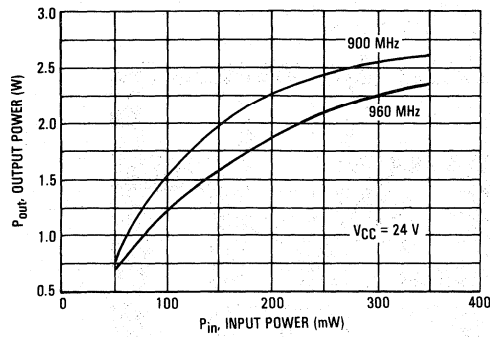


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

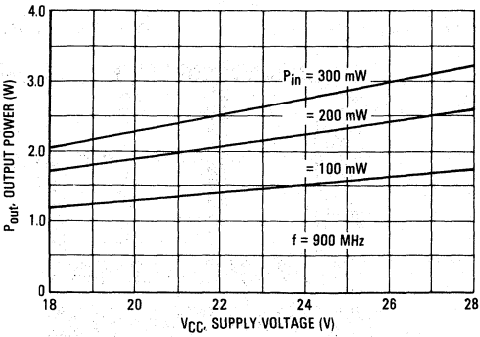


FIGURE 4 — OUTPUT POWER versus FREQUENCY

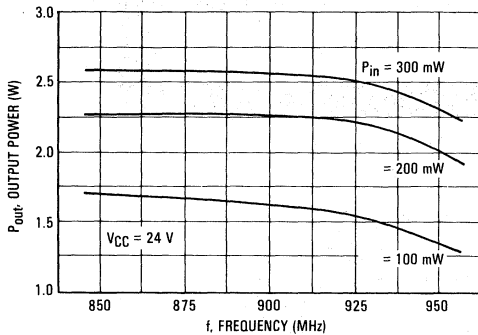


FIGURE 5 — TYPICAL PERFORMANCE IN BROADBAND CIRCUIT

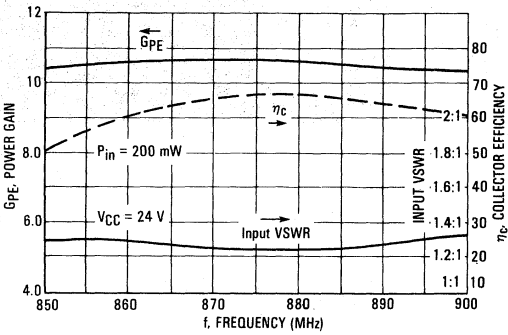


FIGURE 6 — SERIES EQUIVALENT INPUT IMPEDANCE

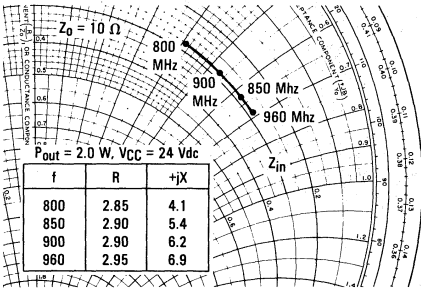
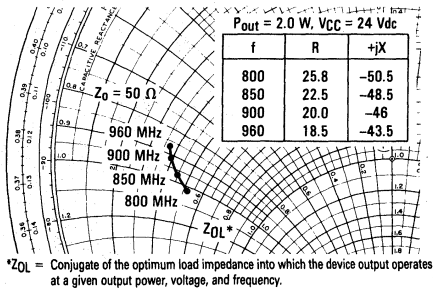
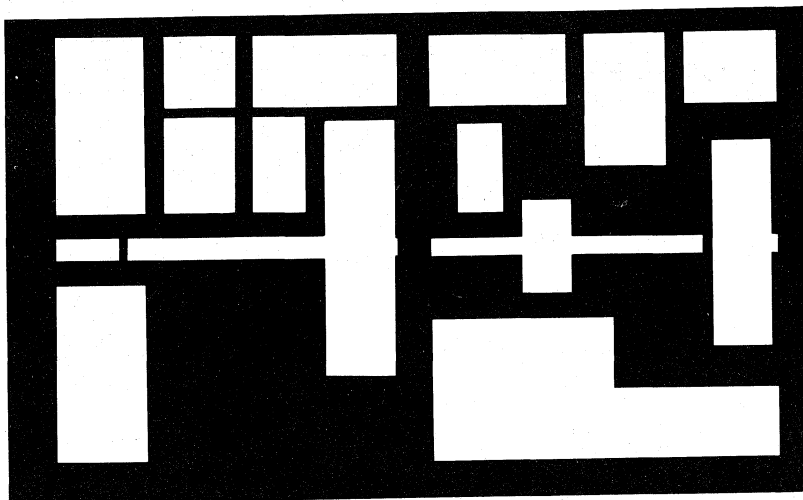


FIGURE 7 — SERIES EQUIVALENT OUTPUT IMPEDANCE



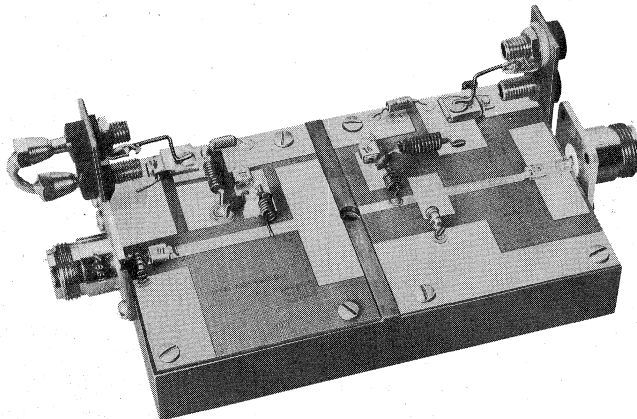
* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 8 — PHOTOMASTER FOR TEST FIXTURE



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 9 — 850-900 MHz TEST CIRCUIT



MRF891

The RF Line

NPN SILICON RF POWER TRANSISTOR

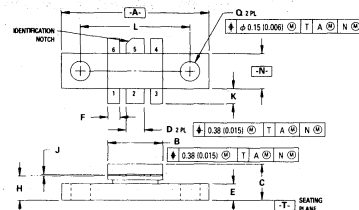
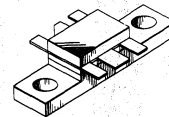
... designed for 24 volt UHF large-signal, common-emitter amplifier applications in industrial and commercial FM equipment operating in the range of 800–960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
Output Power = 5.0 Watts
Minimum Gain = 9.0 dB
Efficiency = 50%
- Series Equivalent Large-Signal Characterization
- Capable of withstanding 20:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

5.0 W 900 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



- STYLE 2:
PIN 1. EMITTER (COMMON)
2. BASE (INPUT)
3. EMITTER (COMMON)
4. EMITTER (COMMON)
5. COLLECTOR (OUTPUT)
6. EMITTER (COMMON)

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Emitter Voltage	V_{CES}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	0.6	Adc
Total Device Dissipation @ $T_A = 50^\circ\text{C}$ Derate above 50°C (1)	P_D	18 0.143	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	7.0	$^\circ\text{C/W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 200\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	30	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 24\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	5.1	7.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (Broadband) ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 900\text{ MHz}$)	G_{pe}	9.0	10	—	dB
Collector Efficiency ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 900\text{ MHz}$)	η	50	57	—	%
Load Mismatch Stress ($V_{CC} = 24\text{ Vdc}$, $P_{in} = 0.63\text{ W}$, $f = 900\text{ MHz}$, $VSWR = 20:1$, all phase angles)	ψ	No degradation in output power			

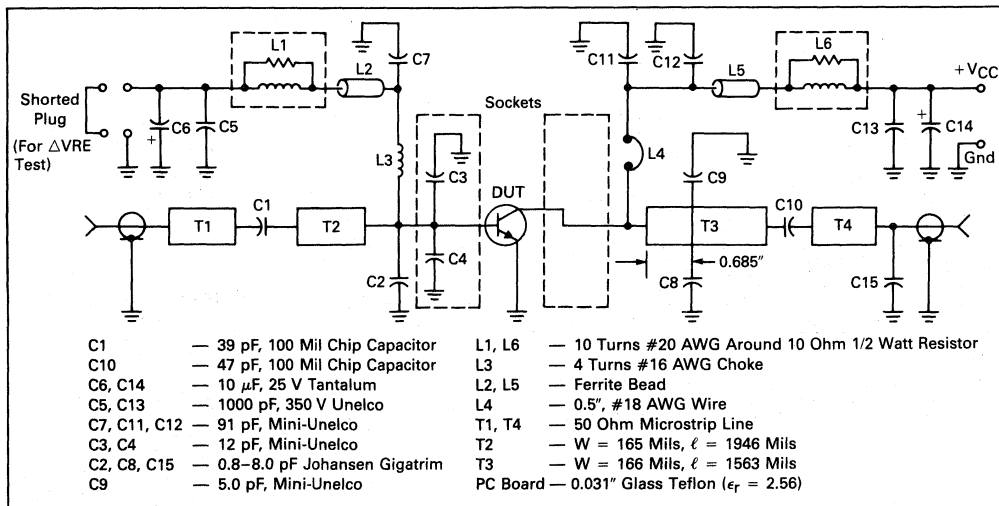
FIGURE 1 — BROADBAND TEST FIXTURE

FIGURE 2 — OUTPUT POWER versus INPUT POWER

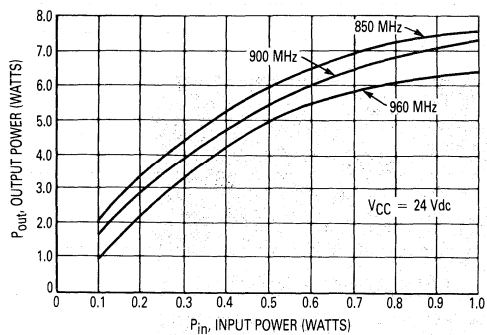


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

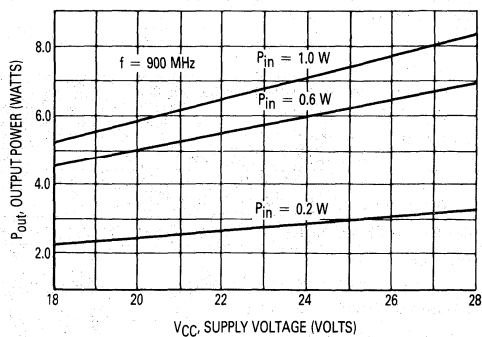


FIGURE 4 — OUTPUT POWER versus FREQUENCY

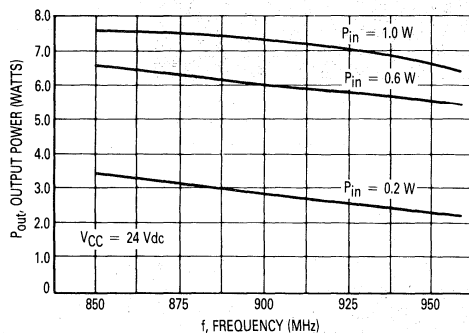


FIGURE 5 — TYPICAL BROADBAND CIRCUIT PERFORMANCE

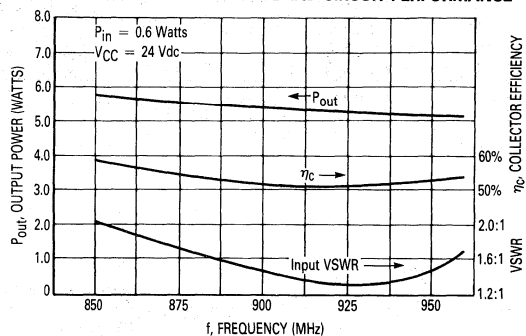


FIGURE 6 — SERIES EQUIVALENT INPUT IMPEDANCE

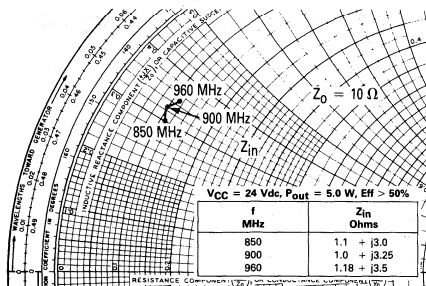


FIGURE 7 — SERIES EQUIVALENT OUTPUT IMPEDANCE

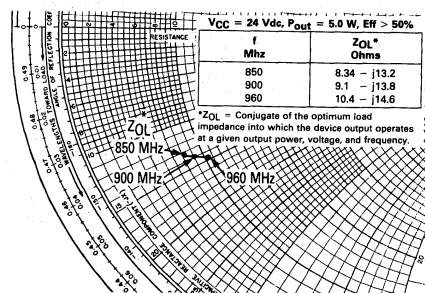
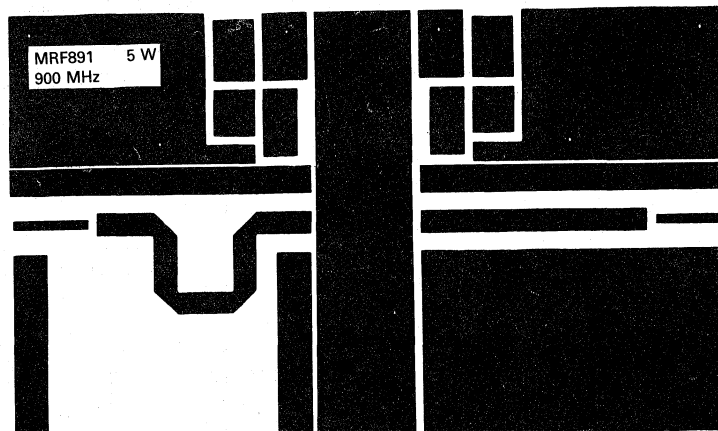
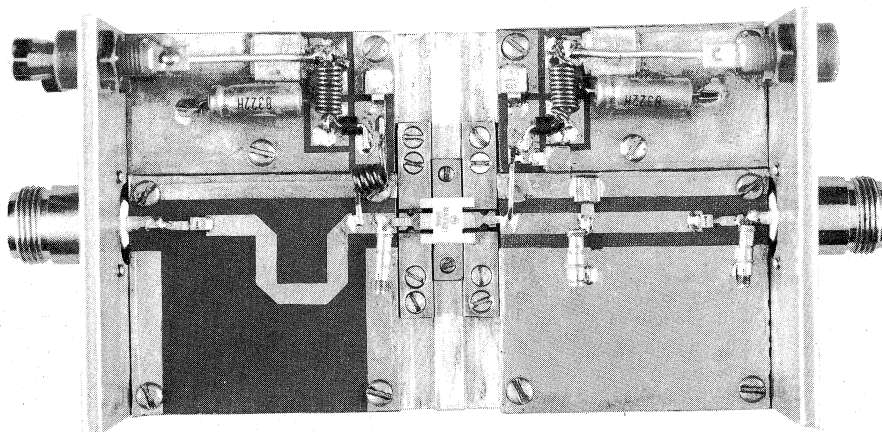


FIGURE 8 — PHOTOMASTER FOR TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 9 — BROADBAND TEST CIRCUIT



MRF892

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 24 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 804 - 960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
Output Power = 14 Watts
Minimum Gain = 8.5 dB
Efficiency = 55%
- Series Equivalent Large-Signal Characterization
- Capable of 30:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	50.0 V	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	50 0.29	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

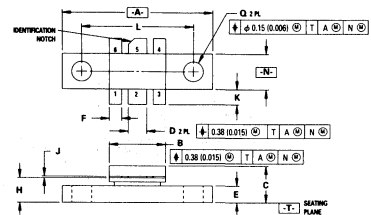
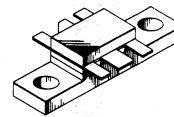
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	3.5	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

14 W 900 MHz

RF POWER TRANSISTOR

NPN SILICON



STYLE 1:

- PIN 1. BASE (COMMON)
- EMITTER (INPUT)
- BASE (COMMON)
- BASE (COMMON)
- COLLECTOR (OUTPUT)
- BASE (COMMON)

NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.

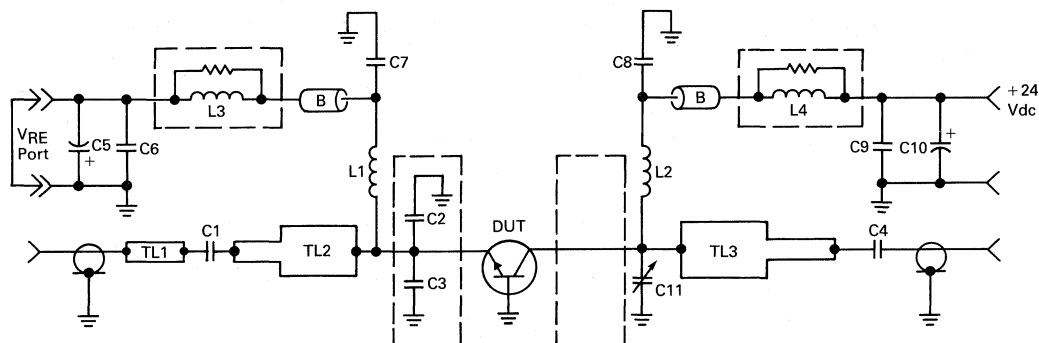
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	2.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	12.5	—	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain ($P_{out} = 14\text{ W}$, $V_{CC} = 24\text{ Vdc}$, $f = 900\text{ MHz}$)	G_{PE}	8.5	9.5	—	dB
Collector Efficiency ($P_{out} = 14\text{ W}$, $V_{CC} = 24\text{ Vdc}$, $f = 900\text{ MHz}$)	η	55	60	—	%

FIGURE 1 — 850–900 MHz BROADBAND CIRCUIT SCHEMATIC



C1 — 51 pF, 100 Mil Chip Capacitor
 C2, C3 — 13 pF Mini-Unelco
 C4 — 43 pF, 100 Mil Chip Capacitor
 C5, C10 — 10 μF , 35 WV
 C6, C9 — 500 pF Unelco J101
 C7, C8 — 91 pF Mini-Unelco
 C11 — 0.8–8.0 pF Johanson Gigatrim
 L1, L2 — 4 Turns #18 Enameled, 5/32" ID
 L3, L4 — 14 Turns #22 Enameled Over 10 Ω Carbon Resistor

B — Ferrite Bead, Ferroxcube 56-590-65-3B
 TL1 — Micro Strip, 50 Ω
 TL2 — Micro Strip, $Z_0 = 26\ \Omega$, $\lambda/4$ @ 875 MHz
 TL3 — Micro Strip, $Z_0 = 14\ \Omega$, $\lambda/4$ @ 875 MHz
 Board — 0.032" Glass Teflon
 2 oz. Cu CLAD, $\epsilon_r = 2.55$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

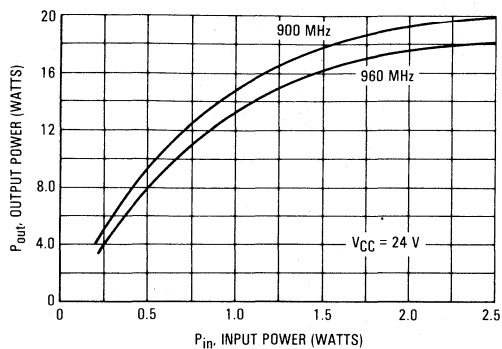


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

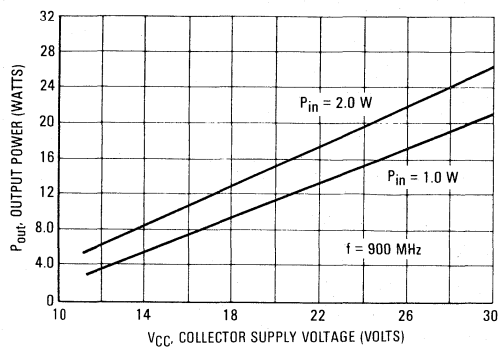


FIGURE 4 — OUTPUT POWER versus FREQUENCY

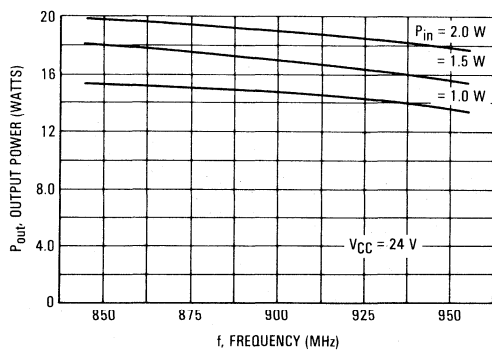


FIGURE 5 — TYPICAL PERFORMANCE IN BROADBAND CIRCUIT

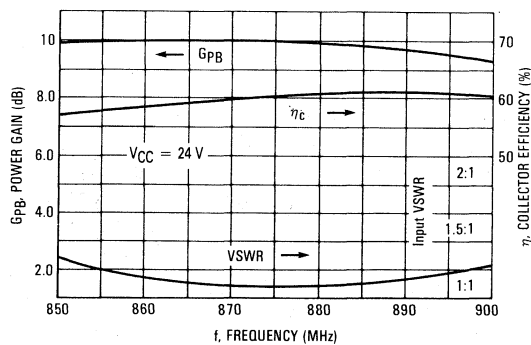


FIGURE 6 — SERIES EQUIVALENT INPUT IMPEDANCE

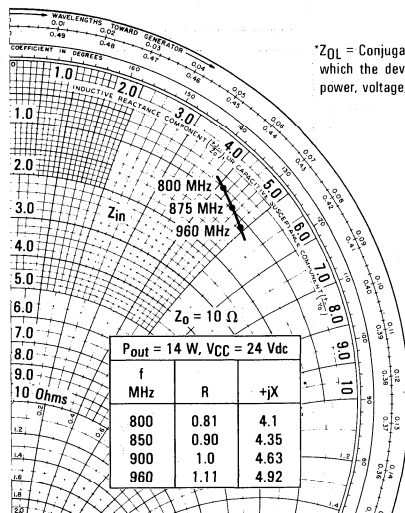


FIGURE 7 — SERIES EQUIVALENT OUTPUT IMPEDANCE

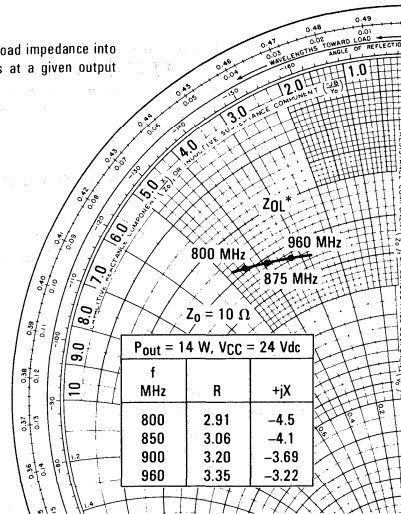
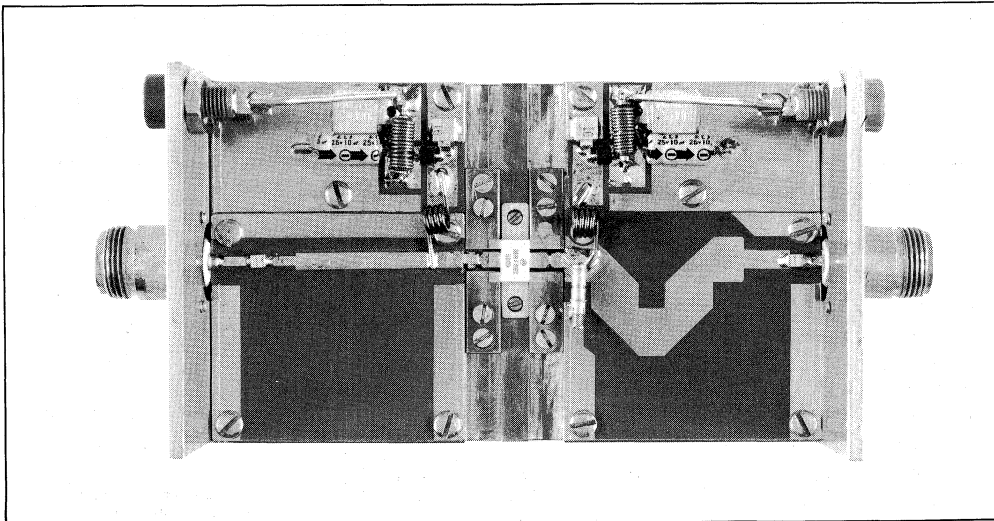


FIGURE 8 — 850-900 MHz TEST CIRCUIT



MRF894

The RF Line

NPN SILICON RF POWER TRANSISTOR

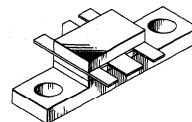
... designed for 24 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 804 - 960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
Output Power = 30 Watts
Minimum Gain = 7.0 dB
Efficiency = 55%
- Series Equivalent Large-Signal Characterization
- Capable of 30:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

30 W 900 MHz

RF POWER TRANSISTOR

NPN SILICON



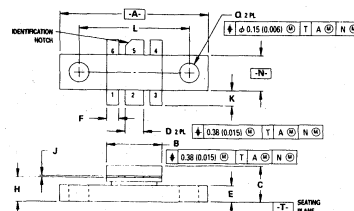
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	7.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate Above 25°C	P_D	115 0.66	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.5	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 1:

- PIN 1. BASE (COMMON)
- EMITTER (INPUT)
- BASE (COMMON)
- BASE (COMMON)
- COLLECTOR (OUTPUT)
- BASE (COMMON)

NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: INCH.

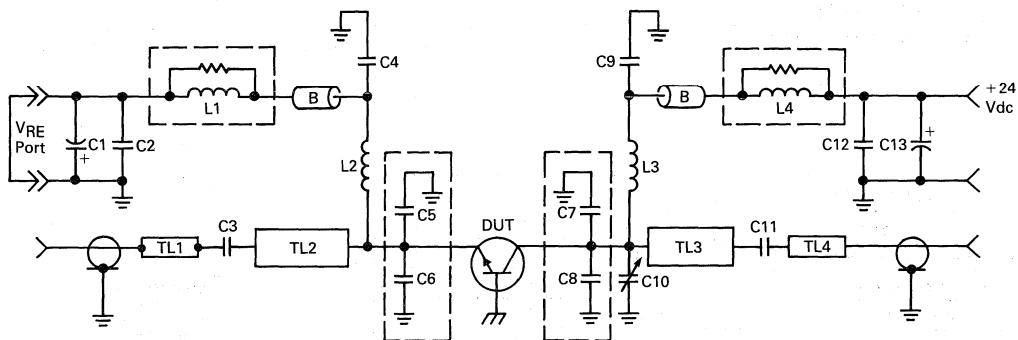
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
G	4.07	4.31	0.160	0.170
H	0.11	0.15	0.004	0.006
J	2.29	2.79	0.090	0.110
K	18.42 BSC		0.725 BSC	
L	5.72	6.12	0.225	0.241
M	3.18	3.42	0.125	0.135

CASE 319-06

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	45	—	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain ($P_{out} = 30\text{ W}$, $V_{CC} = 24\text{ Vdc}$, $f = 900\text{ MHz}$)	G_{PB}	7.0	8.5	—	dB
Collector Efficiency ($P_{out} = 30\text{ W}$, $V_{CC} = 24\text{ Vdc}$, $f = 900\text{ MHz}$)	η	55	60	—	%

FIGURE 1 — 850-900 MHz BROADBAND CIRCUIT SCHEMATIC



C1, C13 — 5 μF , 50 Vdc
 C2, C12 — 1000 pF Unelco
 C3, C11 — 47 pF, 100 Mil Chip Capacitor
 C4, C9 — 91 pF, Mini-Underwood
 C5, C6 — 12 pF, Mini-Underwood
 C7 — 18 pF, Mini-Underwood
 C8 — 24 pF, Mini-Underwood
 C10 — 0.8–8.0 pF Johanson Gigatrim

L1, L4 — 11 Turns #20 Enameled Over 10 Ω Carbon Resistor
 L2, L3 — 4 Turns #20 Enameled, .15" ID
 B — Ferrite Bead, Ferroxcube 56-590-65-3B
 TL1, TL4 — Micro Strip Line, 50 Ω
 TL2 — Micro Strip, $Z_0 = 30\ \Omega$, $\lambda/4$ @ 875 MHz
 TL3 — Micro Strip, $Z_0 = 22\ \Omega$, $\lambda/4$ @ 875 MHz
 Board — 0.032" Glass Teflon
 2 oz. Cu CLAD, $\epsilon_r = 2.55$

TYPICAL CHARACTERISTICS

FIGURE 2 — OUTPUT POWER versus INPUT POWER

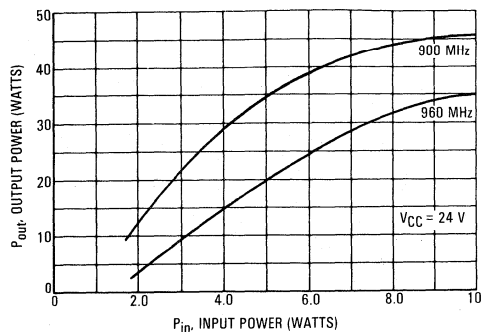


FIGURE 3 — OUTPUT POWER versus FREQUENCY

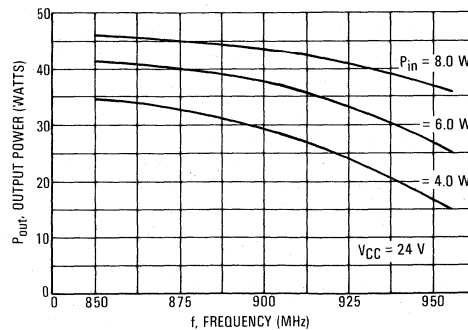


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

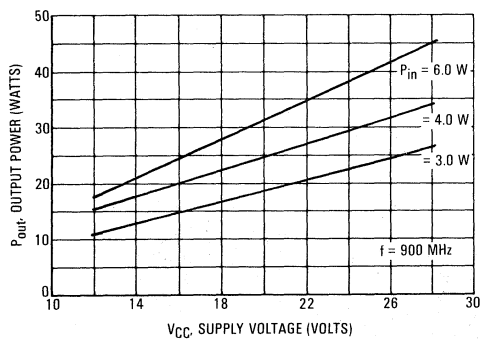


FIGURE 5 — TYPICAL BROADBAND CIRCUIT PERFORMANCE

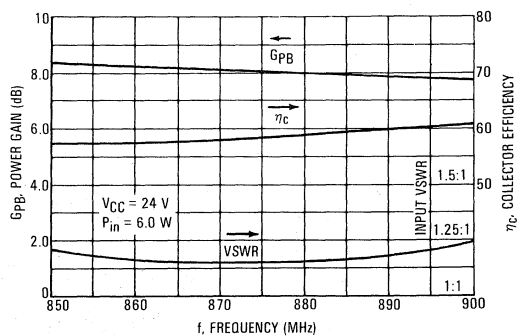


Figure 1 is a Smith Chart used for impedance calculations. The chart shows the normalized load impedance $z_L = 2 - j1$ (labeled as 100 - j50 Ω). The required series impedance Z_{0L}^* is found to be $1.5 + j0.5 \Omega$. The resulting input impedance Z_{in} is $100 + j0 \Omega$. The chart also shows the required series inductor value $L = 0.5 \text{ nH}$.

f Frequency MHz	Z _{in} Ohms	Z _{OL} * Ohms
800	0.9 + j4.5	1.0 + j0.7
850	1.3 + j4.7	1.1 + j0.9
900	1.6 + j4.4	1.2 + j1.1
960	1.5 + j3.7	1.2 + j1.3

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

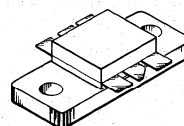
The RF Line
NPN Silicon
RF Power Transistor

... designed for 24 Volt UHF large-signal, common base amplifier applications in industrial and commercial FM equipment operating in the range 850–960 MHz.

- Motorola Advanced Amplifier Concept Package
- Specified 24 Volt, 900 MHz Characteristics
 - Output Power = 60 Watts
 - Minimum Gain = 7 dB
 - Efficiency = 60%
- Double Input/Output Matched for Wideband Performance and Simplified External Matching
- Series Equivalent Large-Signal Characterization
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

MRF898

60 WATTS, 850–960 MHz
RF POWER TRANSISTOR
NPN SILICON



CASE 333A-02, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	175 1	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

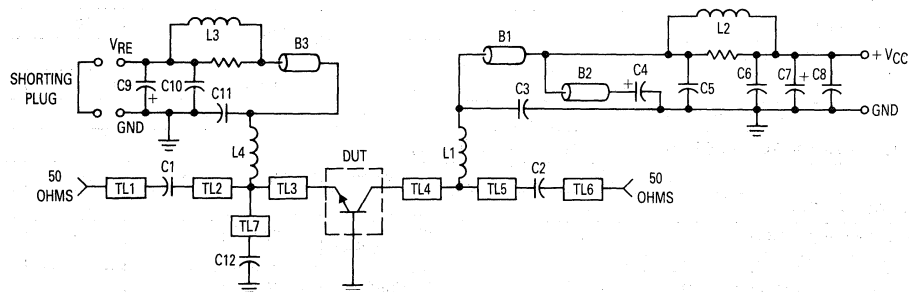
Characteristic	Symbol	Min	Typ	Max	Unit
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	10	mAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2 \text{ Adc}$, $V_{CE} = 5 \text{ Vdc}$)	h_{FE}	20	50	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance* ($V_{CB} = 24 \text{ Vdc}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	60	—	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CC} = 24 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 900 \text{ MHz}$)	G_{pb}	7	7.9	—	dB
Collector Efficiency ($V_{CC} = 24 \text{ Vdc}$, $P_{out} = 60 \text{ W}$, $f = 900 \text{ MHz}$)	η	60	65	—	%
Output Mismatch Stress $V_{CC} = 24 \text{ V}$, $P_{out} = 60 \text{ Watt}$, $f = 900 \text{ MHz}$, $VSWR = 5:1$ (all phase angles)	ψ	No Degradation in Output Power			

*Value of " C_{ob} " is that of die only. It is not measurable in MRF898 because of internal matching network.



B1, B2, B3 — Bead, Ferroxcube 56-390-65/3B
 C1, C2, C12 — 39 pF, 100 Mil Chip Capacitor
 C3, C11 — 91 pF, Mini Underwood or Equivalent
 C4, C7, C9 — 10 μF , 35 V Electrolytic
 C5 — 4000 pF, 1 kV Ceramic
 C6, C10 — 1000 pF, 350 V Unelco or Equivalent
 C8 — 47 pF, 100 Mil Chip Capacitor
 L1, L4 — 4 Turns #18 AWG Choke
 L2 — 11 Turns #20 AWG Choke on 10 Ohm, 1 Watt Resistor
 L3 — 3 Turns #18 AWG Choke on 10 Ohm, 1 Watt Resistor

Board — 3M Epsilam-10, 50 Mil
 TL1, TL6 — 50 Ohm Microstrip
 TL2 — 400 x 950 Mils
 TL3, TL4 — 140 x 200 Mils
 TL5 — 320 x 690 Mils
 TL7 — 260 x 230 Mils
 Bias Boards — 1/32" G10 or Equivalent

Figure 1. 850-960 MHz Broadband Test Circuit

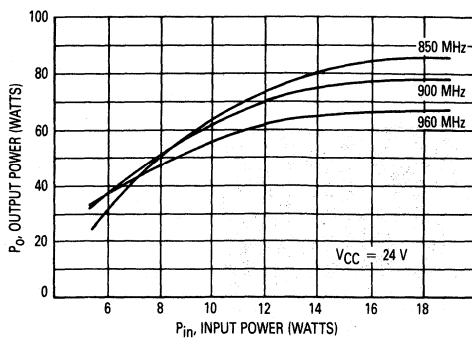


Figure 2. Output Power versus Input Power

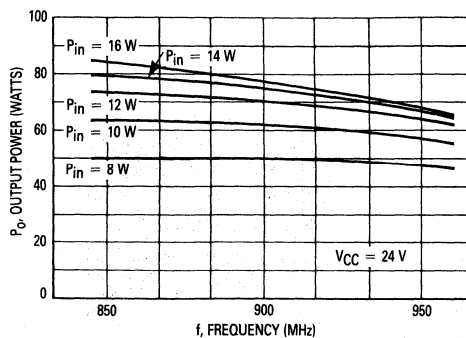


Figure 3. Output Power versus Frequency

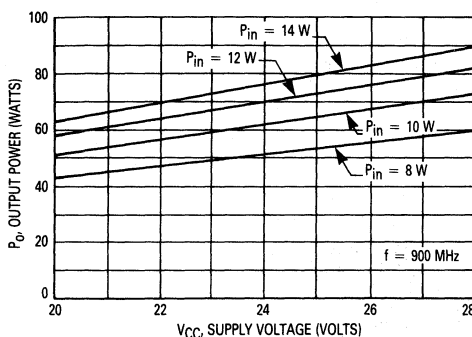


Figure 4. Output Power versus Supply Voltage

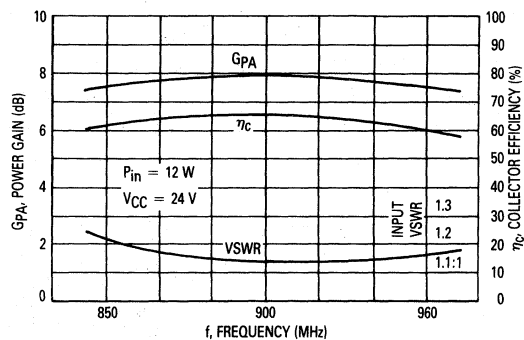


Figure 5. Typical Broadband Circuit Performance

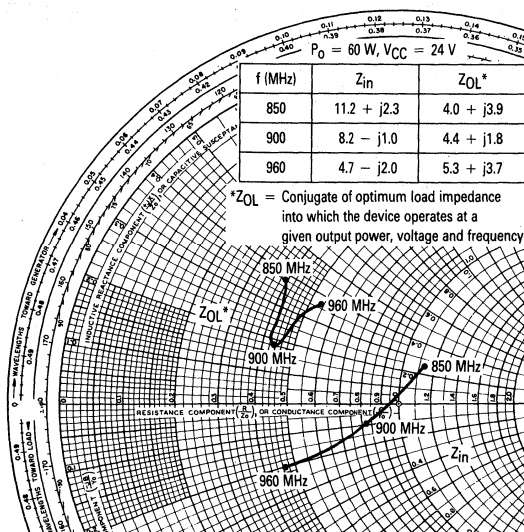
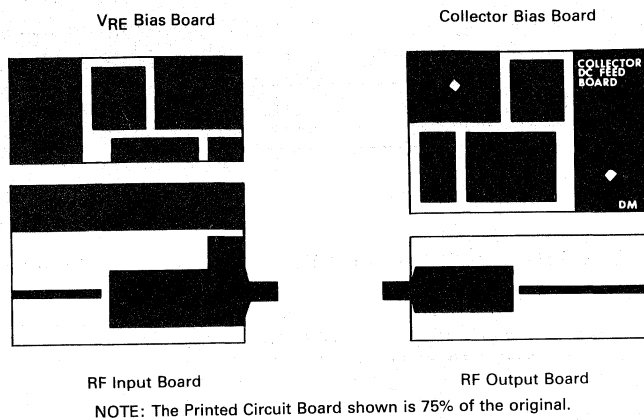
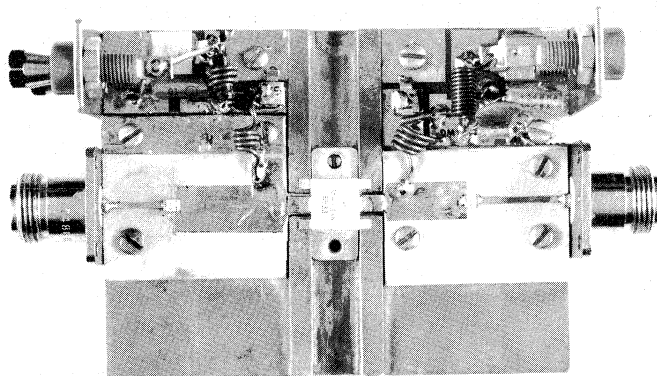


Figure 6. Input/Output Impedance versus Frequency

**Figure 7. Photomaster****Figure 8. 850-960 Broadband Test Circuit**

MRF901

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

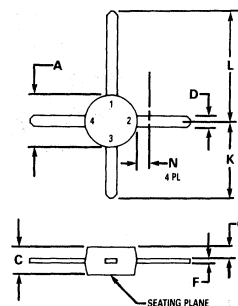
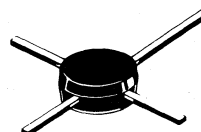
... designed primarily for use in high-gain, low-noise small-signal amplifiers. Also usable in applications requiring fast switching times.

- High Current-Gain-Bandwidth Product — $f_T = 4.5 \text{ GHz (Typ) @ } I_C = 15 \text{ mAdc}$
- Low Noise Figure @ $f = 1.0 \text{ GHz}$ — $NF = 2.0 \text{ dB (Typ)}$ and 2.5 dB (Max)
- High Power Gain — $G_{pe} = 10 \text{ dB (Min) @ } f = 1.0 \text{ GHz}$
- Third Order Intercept = $+23 \text{ dBm (Typ)}$

2.5 dB @ 1.0 GHz

**HIGH FREQUENCY
TRANSISTOR**

NPN SILICON



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	30	mA
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	0.375 3.3	Watt mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	150	$^\circ\text{C}$

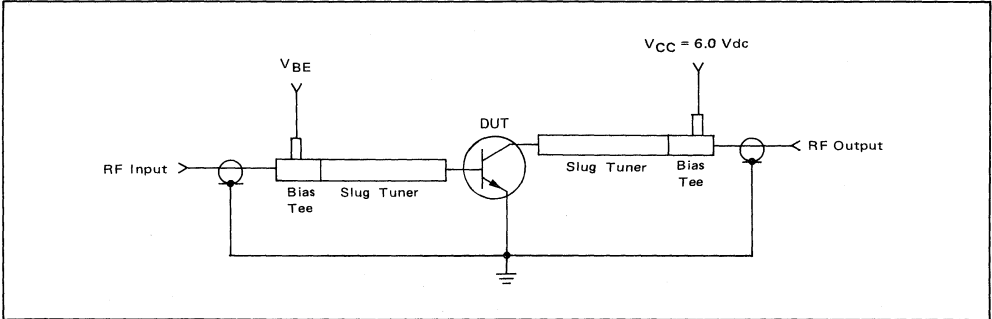
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	300	$^\circ\text{C/W}$

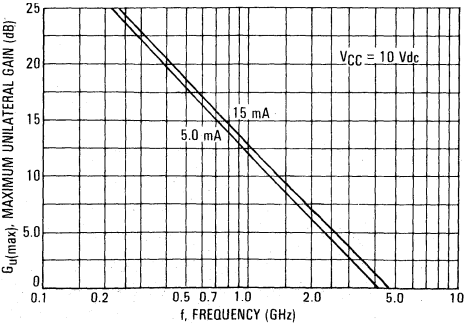
ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	30	80	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product ($I_C = 15\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ GHz}$)	f_T	—	4.5	—	GHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{cb}	—	0.4	1.0	pF
Noise Figure ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 1.0\text{ GHz}$)	NF	—	2.0	2.5	dB
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 6.0\text{ Vdc}$, $I_C = 5.0\text{ mA}$, $f = 1.0\text{ GHz}$)	G_{pe}	10	12	—	dB
Third Order Intercept ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 0.9\text{ GHz}$)	—	—	+23	—	dBm

FIGURE 1 — 1.0 GHz TEST CIRCUIT SCHEMATIC



**FIGURE 2 — MAXIMUM UNILATERAL GAIN
versus FREQUENCY**



**FIGURE 3 — CURRENT GAIN — BANDWIDTH PRODUCT
versus COLLECTOR CURRENT**

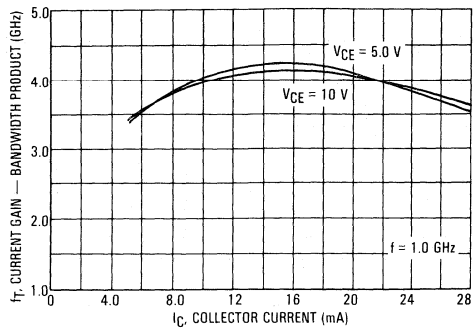
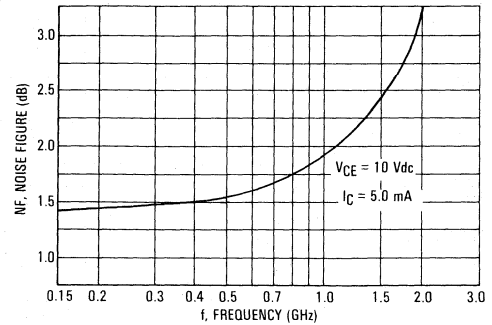
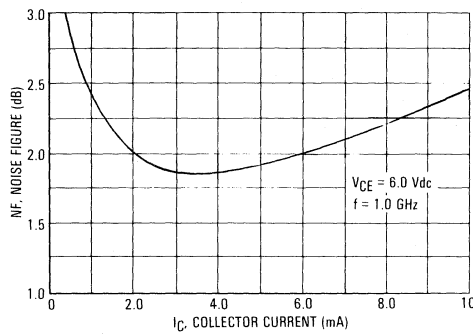


FIGURE 4 — NOISE FIGURE versus FREQUENCY



**FIGURE 5 — NOISE FIGURE versus
COLLECTOR CURRENT**



**FIGURE 6 — MAXIMUM UNILATERAL GAIN
versus COLLECTOR CURRENT**

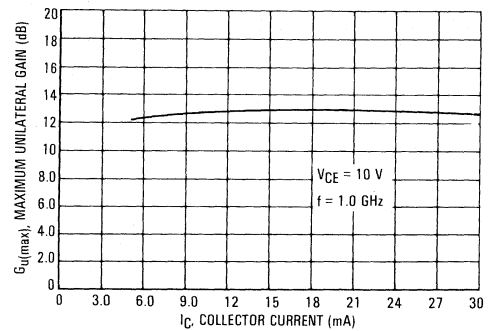
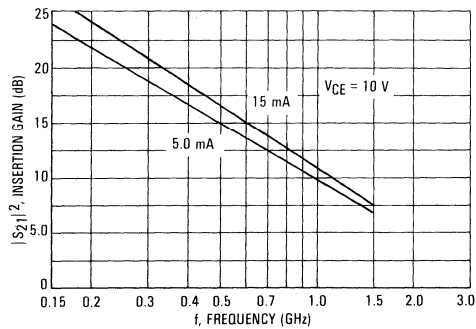


FIGURE 7 — $|S_{21}|^2$ versus FREQUENCY



**FIGURE 8 — COLLECTOR-BASE CAPACITANCE
versus COLLECTOR-BASE VOLTAGE**

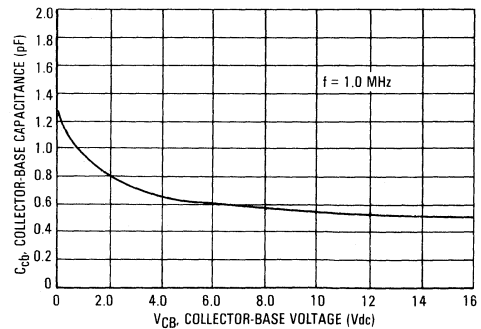


TABLE I

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	$\angle\phi$	|S21|	$\angle\phi$	|S12|	$\angle\phi$	|S22|	$\angle\phi$
5.0	5.0	100	0.71	-38	11.30	153	0.03	68	0.92	-17
		200	0.62	-75	9.48	133	0.05	55	0.76	-29
		500	0.54	-141	5.40	100	0.07	43	0.48	-44
		1000	0.53	178	2.93	76	0.09	48	0.40	-56
		2000	0.59	130	1.51	48	0.16	62	0.35	-85
	10	100	0.57	-58	16.95	145	0.03	63	0.85	-23
		200	0.51	-103	12.61	123	0.04	53	0.64	-35
		500	0.52	-161	6.24	93	0.06	50	0.38	-45
		1000	0.52	166	3.24	73	0.09	61	0.33	-54
		2000	0.59	125	1.66	47	0.17	67	0.29	-84
	15	100	0.48	-75	20.08	139	0.02	61	0.80	-27
		200	0.47	-121	13.89	117	0.04	53	0.57	-38
		500	0.53	-170	6.44	91	0.05	56	0.34	-44
		1000	0.53	162	3.33	72	0.09	66	0.31	-52
		2000	0.60	123	1.70	46	0.18	68	0.28	-82
	20	100	0.44	-88	21.62	136	0.02	60	0.76	-28
		200	0.47	-132	14.33	114	0.03	54	0.53	-38
		500	0.53	-175	6.45	89	0.05	60	0.32	-41
		1000	0.53	159	3.31	70	0.09	68	0.31	-50
		2000	0.61	122	1.69	45	0.18	70	0.28	-80
	30	100	0.43	-112	21.45	130	0.02	58	0.72	-28
		200	0.50	-148	13.38	109	0.03	57	0.51	-33
		500	0.57	178	5.82	86	0.05	65	0.35	-34
		1000	0.57	156	2.99	68	0.08	73	0.35	-46
		2000	0.65	121	1.50	42	0.18	74	0.33	-78

TABLE II

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	$\angle\phi$	|S21|	$\angle\phi$	|S12|	$\angle\phi$	|S22|	$\angle\phi$
10	5.0	100	0.73	-35	11.32	154	0.03	69	0.93	-14
		200	0.63	-69	9.69	135	0.05	57	0.79	-25
		500	0.53	-135	5.65	101	0.07	43	0.54	-38
		1000	0.51	-177	3.11	77	0.08	50	0.47	-48
		2000	0.57	132	1.58	48	0.14	66	0.41	-75
	10	100	0.59	-52	17.06	147	0.02	64	0.87	-19
		200	0.52	-95	13.06	125	0.04	54	0.69	-30
		500	0.49	-156	6.58	95	0.05	51	0.45	-37
		1000	0.50	170	3.44	74	0.08	62	0.41	-45
		2000	0.57	126	1.75	47	0.16	70	0.36	-72
	15	100	0.51	-66	20.36	141	0.02	63	0.83	-22
		200	0.47	-112	14.48	119	0.03	54	0.63	-31
		500	0.50	-166	6.81	92	0.05	57	0.41	-35
		1000	0.50	164	3.54	72	0.08	67	0.39	-43
		2000	0.58	124	1.78	46	0.16	72	0.35	-70
	20	100	0.47	-78	22.08	138	0.02	61	0.80	-23
		200	0.46	-123	15.07	116	0.03	55	0.60	-30
		500	0.50	-171	6.84	90	0.05	60	0.40	-32
		1000	0.51	162	3.51	71	0.08	69	0.39	-41
		2000	0.59	123	1.77	45	0.17	73	0.35	-68
	30	100	0.44	-98	22.70	133	0.02	59	0.76	-23
		200	0.47	-139	14.47	111	0.03	55	0.57	-27
		500	0.53	-177	6.33	87	0.04	65	0.43	-28
		1000	0.54	158	3.26	69	0.07	74	0.43	-39
		2000	0.62	122	1.61	42	0.16	77	0.39	-68

FIGURE 9 — INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY
($V_{CE} = 10\text{ V}$, $I_C = 15\text{ mA}$)

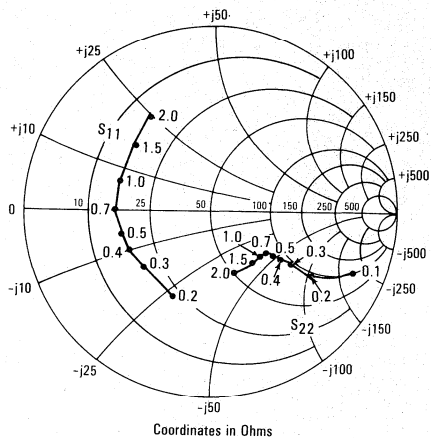


FIGURE 10 — FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY
($V_{CE} = 10\text{ V}$, $I_C = 15\text{ mA}$)

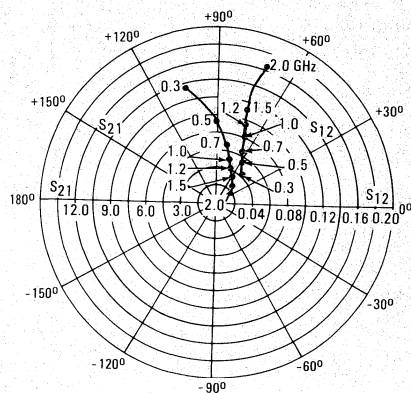
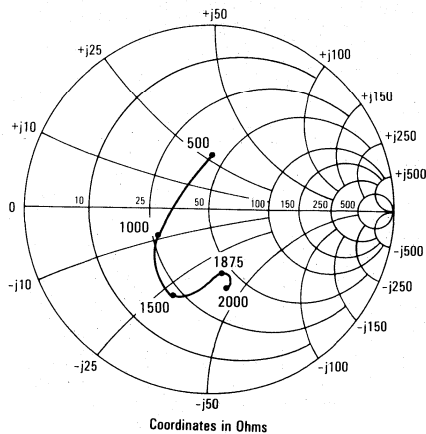
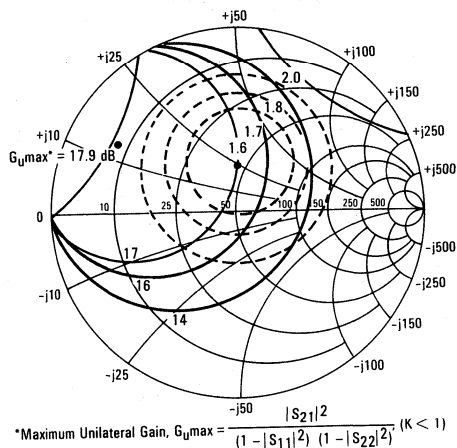


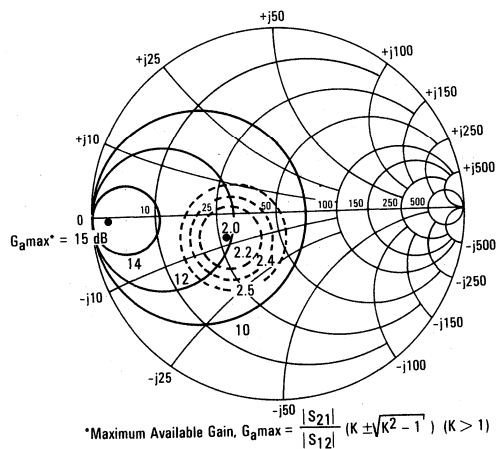
FIGURE 11 — SOURCE IMPEDANCE (Γ_{ms}) FOR OPTIMUM NOISE FIGURE versus FREQUENCY
($V_{CE} = 10\text{ Vdc}$, $I_C = 5.0\text{ mA}$)



**FIGURE 12 — CONSTANT GAIN AND NOISE
FIGURE CONTOURS**
($V_{CE} = 10$ Vdc, $I_C = 5.0$ mA $f = 500$ MHz)



**FIGURE 13 — CONSTANT GAIN AND NOISE
FIGURE CONTOURS**
($V_{CE} = 10$ Vdc, $I_C = 5.0$ mA $f = 1.0$ GHz)



MOTOROLA SEMICONDUCTOR TECHNICAL DATA

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

... designed for use as low-noise, high-gain, general purpose amplifiers.

- High Current-Gain — Bandwidth Product —
 $f_T = 4.0 \text{ GHz (Typ) @ } I_C = 15 \text{ mAdc}$
- Low Noise Figure —
 $NF = 1.5 \text{ dB (Typ) @ } f = 450 \text{ MHz}$
 $= 2.5 \text{ dB (Typ) @ } f = 1.0 \text{ GHz}$
- High Power Gain —
 $G_{max} = 16 \text{ dB (Typ) @ } f = 450 \text{ MHz}$
 $= 10 \text{ dB (Typ) @ } f = 1.0 \text{ GHz}$
- Excellent Third Order Intercept — $+25 \text{ dBm (Typ)}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	30	mAdc
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	0.2 1.14	Watt mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	50	nAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	30	—	200	—
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DYNAMIC CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 15 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ GHz}$)	f_T	—	4.0	—	GHz
Collector-Base Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{cb}	—	—	1.0	pF
Noise Figure ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 6.0 \text{ Vdc}$, $f = 450 \text{ MHz}$) ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 6.0 \text{ Vdc}$, $f = 1.0 \text{ GHz}$)	NF	—	1.5 2.5	—	dB

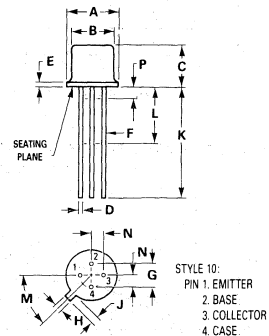
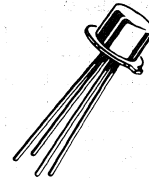
FUNCTIONAL TEST

Unilateralized Gain ⁽¹⁾ ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 6.0 \text{ Vdc}$, $f = 450 \text{ MHz}$) ($I_C = 5.0 \text{ mAdc}$, $V_{CE} = 6.0 \text{ Vdc}$, $f = 1.0 \text{ GHz}$)	G_{max}	—	16 10	—	dB
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$$(1) G_{max} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

MRF904

HIGH FREQUENCY TRANSISTOR NPN SILICON



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC	—	0.100 BSC	—
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC	—	45° BSC	—
N	1.27 BSC	—	0.050 BSC	—
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

FIGURE 1 – NOISE FIGURE versus FREQUENCY

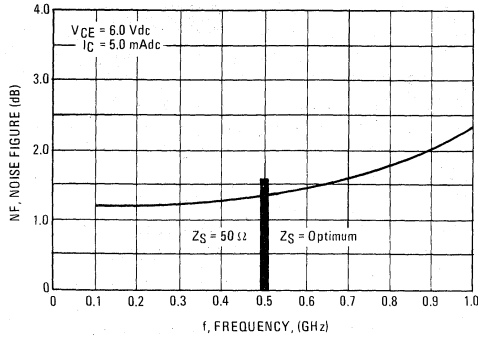


FIGURE 2 – NOISE FIGURE versus COLLECTOR CURRENT

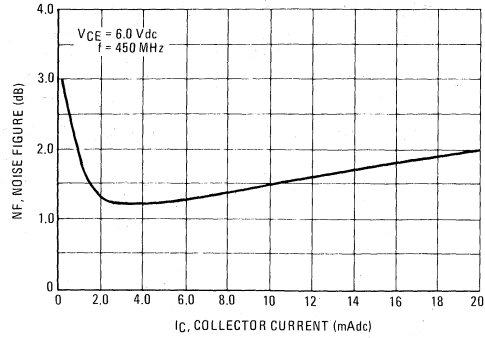


FIGURE 3 – COLLECTOR-BASE CAPACITANCE versus COLLECTOR-BASE VOLTAGE

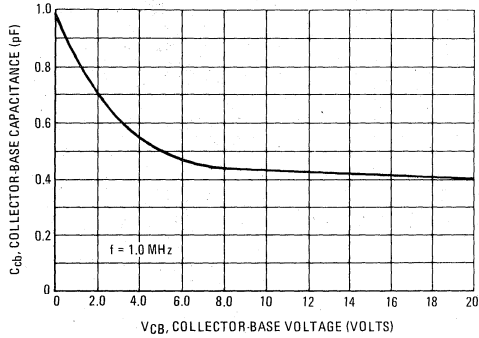


FIGURE 4 – UNILATERALIZED GAIN (G_{max}) versus FREQUENCY

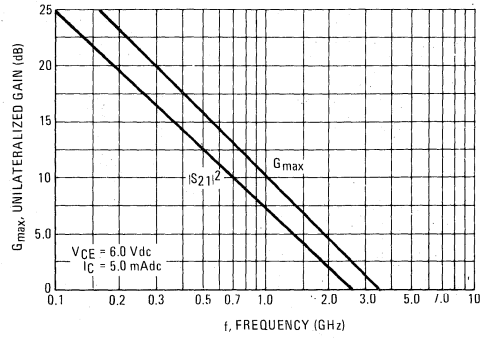


FIGURE 5 – CURRENT-GAIN – BANDWIDTH PRODUCT versus COLLECTOR CURRENT

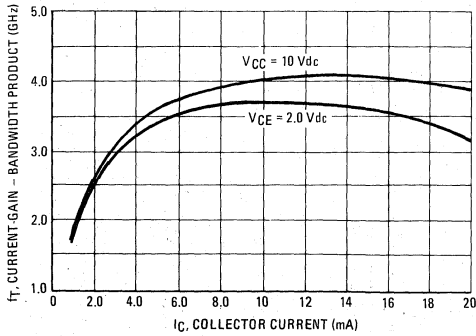


FIGURE 6 – INTERMODULATION DISTORTION versus COLLECTOR CURRENT

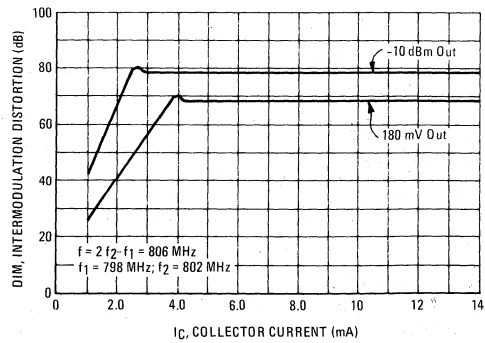


TABLE 1 – S₁₁ PARAMETERS

Frequency (MHz)		100		200		500		800		1000	
V _{CC} (Volts)	I _C (mA)										
1.0	1.0	0.941	-22	0.85	-43	0.57	-91	0.37	-128	0.30	-151
	2.5	0.85	-31	0.67	-57	0.35	-102	0.20	-136	0.14	-157
	5.0	0.69	-44	0.46	-71	0.21	-109	0.10	-144	0.069	-166
	10	0.45	-67	0.28	-94	0.13	-136	0.087	172	0.075	145
	15	0.37	-110	0.31	-145	0.26	170	0.27	139	0.27	122
	30	0.71	-178	0.71	169	0.68	144	0.68	121	0.65	107
3.0	1.0	0.94	-19	0.87	-37	0.61	-80	0.39	-114	0.30	-134
	2.5	0.87	-26	0.71	-47	0.39	-84	0.21	-106	0.15	-115
	5.0	0.74	-34	0.52	-55	0.25	-77	0.13	-82	0.109	-79
	10	0.55	-42	0.35	-58	0.18	-66	0.11	-60	0.105	-55
	15	0.46	-46	0.28	-59	0.15	-64	0.096	-55	0.092	-49
	30	0.28	-95	0.21	-134	0.16	175	0.17	135	0.17	116
6.0	1.0	0.95	-18	0.88	-35	0.63	-76	0.40	-108	0.30	-126
	2.5	0.89	-23	0.74	-43	0.42	-77	0.23	-94	0.17	-100
	5.0	0.77	-31	0.56	-49	0.29	-67	0.18	-69	0.15	-66
	10	0.61	-37	0.40	-50	0.23	-55	0.16	-51	0.16	-50
	15	0.52	-40	0.34	-51	0.20	-52	0.15	-47	0.15	-47
	30	0.36	-55	0.21	-70	0.098	-77	0.037	-59	0.033	-27
10	1.0	0.96	-17	0.89	-33	0.65	-73	0.41	-103	0.31	-121
	2.5	0.89	-22	0.76	-41	0.44	-73	0.25	-88	0.18	-93
	5.0	0.79	-28	0.59	-46	0.32	-63	0.20	-65	0.18	-63
	10	0.64	-34	0.44	-47	0.26	-52	0.19	-49	0.18	-49
	15	0.57	-37	0.38	-48	0.23	-49	0.18	-46	0.17	-46
	30	0.41	-51	0.24	-64	0.12	-67	0.061	-52	0.055	-36

TABLE 2 – S₂₁ PARAMETERS

Frequency (MHz)		100		200		500		800		1000	
V _{CC} (Volts)	I _C (mA)										
1.0	1.0	5.32	156	3.06	137	2.22	97	1.65	70	1.44	56
	2.5	6.79	146	5.57	124	3.15	86	2.14	64	1.81	52
	5.0	10.97	133	7.60	110	3.62	79	2.38	61	2.00	49
	10	13.16	118	8.07	99	3.60	74	2.35	57	1.96	46
	15	9.84	108	5.66	91	2.44	67	1.63	49	1.38	38
	30	1.65	83	0.88	69	0.47	46	0.43	37	0.45	31
3.0	1.0	3.33	159	3.11	142	2.36	103	1.79	76	1.55	62
	2.5	6.89	150	5.85	129	3.48	92	2.38	70	2.00	58
	5.0	11.49	138	8.34	115	4.12	84	2.70	66	2.25	55
	10	15.71	125	9.82	104	4.39	79	2.85	63	2.34	53
	15	16.97	119	10.05	100	4.39	77	2.83	61	2.34	52
	30	12.66	108	7.02	92	2.98	70	1.94	54	1.61	44
6.0	1.0	3.31	160	3.10	144	2.41	106	1.83	79	1.60	65
	2.5	6.80	151	5.85	131	3.60	94	2.46	77	2.07	60
	5.0	11.44	140	8.54	117	4.28	86	2.83	68	2.33	57
	10	15.85	127	10.14	107	4.61	81	2.96	65	2.46	55
	15	17.20	122	10.47	102	4.60	79	2.96	63	2.45	54
	30	16.37	113	9.38	96	4.00	75	2.58	59	2.14	49
10	1.0	3.25	160	3.08	145	2.40	108	1.83	81	1.61	67
	2.5	6.73	152	5.85	132	3.63	96	2.50	74	2.10	62
	5.0	11.19	142	8.49	119	4.34	88	2.85	69	2.37	59
	10	15.59	129	10.16	108	4.66	82	3.00	66	2.47	56
	15	17.04	124	10.49	104	4.65	80	2.99	64	2.47	55
	30	16.18	115	9.38	98	4.03	96	2.60	60	2.14	50

TABLE 3 – S₁₂ PARAMETERS

Frequency (MHz)		100		200		500		800		1000	
V _{CC} (Volts)	I _C (mA)	S ₁₂	∠ φ	S ₁₂	∠ φ	S ₁₂	∠ φ	S ₁₂	∠ φ	S ₁₂	∠ φ
1.0	1.0	0.054	73	0.097	61	0.159	41	0.184	36	0.194	37
	2.5	0.051	69	0.084	58	0.140	50	0.189	48	0.220	46
	5.0	0.046	65	0.072	60	0.137	58	0.201	53	0.239	50
	10	0.041	64	0.067	64	0.142	62	0.215	56	0.256	51
	15	0.043	61	0.070	63	0.152	62	0.230	55	0.277	50
	30	0.058	50	0.093	58	0.209	57	0.311	46	0.372	39
3.0	1.0	0.039	75	0.072	65	0.123	46	0.143	42	0.151	44
	2.5	0.037	72	0.063	62	0.110	54	0.150	53	0.174	52
	5.0	0.033	70	0.055	64	0.108	62	0.160	58	0.190	55
	10	0.030	70	0.050	68	0.109	67	0.165	61	0.199	57
	15	0.028	70	0.049	70	0.109	68	0.167	62	0.200	57
	30	0.026	68	0.046	70	0.105	69	0.165	64	0.200	61
6.0	1.0	0.032	76	0.060	66	0.106	49	0.123	45	0.131	48
	2.5	0.031	73	0.054	64	0.095	57	0.130	56	0.151	55
	5.0	0.028	71	0.048	66	0.094	64	0.139	61	0.165	58
	10	0.026	71	0.043	69	0.094	68	0.144	63	0.172	59
	15	0.024	71	0.042	71	0.093	69	0.144	64	0.172	60
	30	0.021	71	0.037	72	0.086	71	0.134	67	0.162	63
10	1.0	0.028	77	0.053	68	0.095	50	0.109	47	0.116	50
	2.5	0.027	74	0.048	65	0.085	58	0.116	57	0.134	57
	5.0	0.025	73	0.043	67	0.084	64	0.125	62	0.148	60
	10	0.023	72	0.037	69	0.084	69	0.128	64	0.153	61
	15	0.022	73	0.037	70	0.084	69	0.128	65	0.152	62
	30	0.019	72	0.033	72	0.076	72	0.119	68	0.143	66

TABLE 4 – S₂₂ PARAMETERS

Frequency (MHz)		100		200		500		800		1000	
V _{CC} (Volts)	I _C (mA)	S ₂₂	∠ φ	S ₂₂	∠ φ	S ₂₂	∠ φ	S ₂₂	∠ φ	S ₂₂	∠ φ
1.0	1.0	0.966	-12	0.893	-23	0.693	-41	0.612	-53	0.594	-59
	2.5	0.901	-18	0.760	-29	0.548	-42	0.498	-51	0.494	-56
	5.0	0.793	-24	0.619	-32	0.456	-39	0.429	-49	0.439	-54
	10	0.635	-29	0.486	-32	0.390	-36	0.377	-47	0.389	-53
	15	0.453	-29	0.364	-29	0.313	-34	0.309	-48	0.321	-14
	30	0.048	-78	0.035	-88	0.032	-135	0.031	-162	0.007	-167
3.0	1.0	0.976	-9.0	0.926	-18	0.770	-35	0.702	-46	0.683	-51
	2.5	0.935	-13	0.828	-23	0.648	-35	0.608	-43	0.608	-48
	5.0	0.853	-18	0.712	-25	0.577	-32	0.555	-41	0.565	-46
	10	0.758	-20	0.629	-23	0.539	-29	0.529	-39	0.544	-44
	15	0.711	-20	0.601	-22	0.533	-27	0.526	-38	0.540	-44
	30	0.631	-15	0.576	-16	0.548	-25	0.546	-38	0.558	-45
6.0	1.0	0.982	-8.0	0.939	-16	0.803	-31	0.742	-42	0.734	-47
	2.5	0.947	-11	0.861	-20	0.699	-31	0.662	-40	0.660	-45
	5.0	0.882	-15	0.759	-21	0.633	-29	0.617	-31	0.627	-43
	10	0.801	-17	0.684	-20	0.607	-26	0.601	-35	0.610	-41
	15	0.769	-17	0.667	-19	0.602	-25	0.601	-35	0.607	-40
	30	0.737	-14	0.672	-15	0.640	-22	0.641	-33	0.655	-40
10	1.0	0.983	-7.0	0.949	-14	0.830	-29	0.774	-39	0.765	-40
	2.5	0.954	-10	0.880	-18	0.733	-29	0.698	-37	0.702	-42
	5.0	0.901	-13	0.793	-19	0.676	-27	0.659	-35	0.668	-41
	10	0.834	-15	0.725	-18	0.646	-24	0.646	-33	0.658	-39
	15	0.802	-15	0.706	-17	0.645	-23	0.648	-33	0.661	-39
	30	0.776	-13	0.712	-14	0.678	-22	0.686	-32	0.699	-38

MRF905

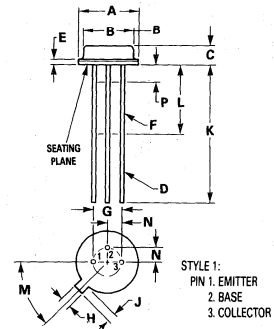
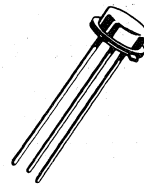
The RF Line

NPN SILICON OSCILLATOR TRANSISTOR

... designed for microwave communications relay links and low-cost radiosonde service.

- Emitter Ballasted
- Low Current Density for Improved Lifetime
- Collector Connected to Case

400 mW
RF OSCILLATOR TRANSISTOR
NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	150	mA dc
Total Power Dissipation @ $T_C = 100^\circ\text{C}$ Derate above 100°C	P_D	0.75 7.5	Watts mW/ $^\circ\text{C}$
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	0.45 2.6	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

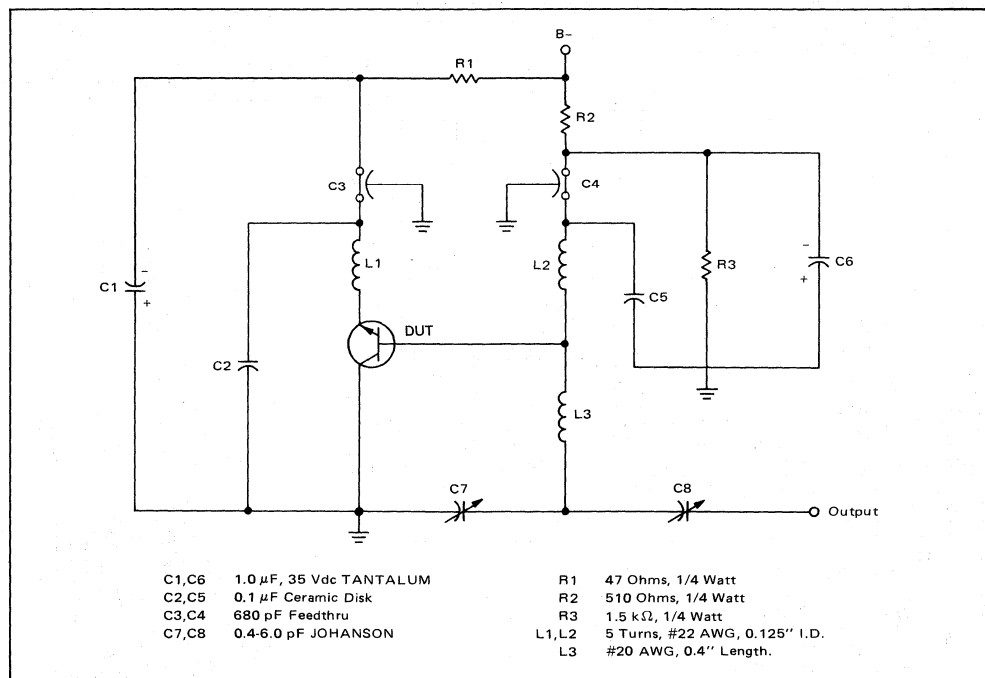
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	133	$^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	380	$^\circ\text{C/W}$

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	1.65	2.16	0.065	0.085
D	0.406	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.305	0.483	0.012	0.019
G	254 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 26-03
TO-206AB
(TO-46)

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	20	30	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 20\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.1	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	20	60	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 200\text{ MHz}$)	f_T	—	2500	—	MHz
Output Capacitance ($V_{CB} = 20\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	3.0	5.0	pF
FUNCTIONAL TEST					
Common-Collector Oscillator Output Power ($V_E = -20\text{ Vdc}$, $I_E \approx 110\text{ mA}$, $f \approx 1.68\text{ GHz}$)	P_{out}	400	500	—	mW

FIGURE 1 — 1.68 GHz OSCILLATOR TEST CIRCUIT SCHEMATIC

MRF911

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

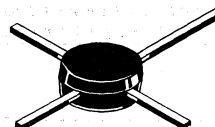
... designed primarily for use in high-gain, low-noise tuned and wideband small-signal amplifiers. Excellent in high-speed switching applications.

- High Current-Gain – Bandwidth Product –
 $f_T = 5.0 \text{ GHz (Typ) @ } f = 1.0 \text{ GHz}$
- High Power Gain –
 $G_{\text{max}} = 12.5 \text{ dB (Typ) @ } f = 1.0 \text{ GHz}$

$f_T = 5.0 \text{ GHz @ } 30 \text{ mA}$

HIGH FREQUENCY TRANSISTOR

NPN SILICON



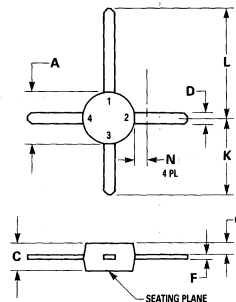
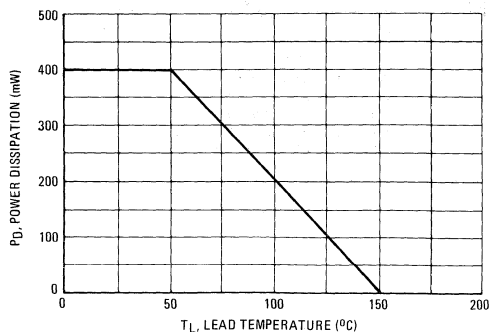
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	12	Vdc
Collector-Base Voltage	V_{CB0}	20	Vdc
Emitter-Base Voltage	V_{EB0}	2.0	Vdc
Collector Current – Peak	I_C	40	mA
Total Device Dissipation @ $T_L = 50^\circ\text{C}$ Derate Above 50°C	P_D	400 4.0	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Lead	$R_{\theta JL}$	250	$^\circ\text{C/W}$

FIGURE 1 – POWER DERATING



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

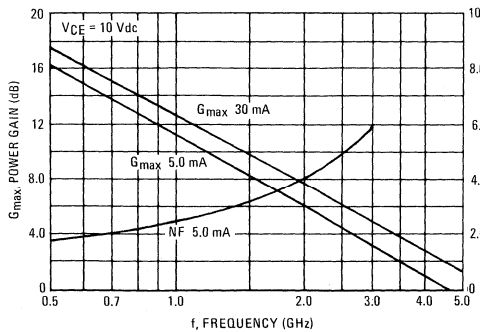
CASE 317-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	12	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 30\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	h_{FE}	30	—	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product ($I_C = 30\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ GHz}$)	f_T	—	5.0	—	GHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{cb}	—	0.6	1.0	pF
FUNCTIONAL TESTS					
Noise Figure ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ GHz}$) ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 2.0\text{ GHz}$)	NF	— —	2.5 4.0	— —	dB
Power Gain at Optimum Noise Figure ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ GHz}$) ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 2.0\text{ GHz}$)	G _{NF}	— —	10 6.0	— —	dB
Maximum Available Power Gain (1) ($I_C = 30\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1.0\text{ GHz}$) ($I_C = 30\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 2.0\text{ GHz}$)	G _{max}	— —	12.5 7.5	— —	dB

$$(1) G_{\max} = \frac{|S_{21}|^2}{(|1-S_{11}|^2)(|1-S_{22}|^2)}$$

**FIGURE 2 – POWER GAIN AND NOISE FIGURE
versus FREQUENCY**



**FIGURE 3 – POWER GAIN AND NOISE FIGURE
versus COLLECTOR CURRENT**

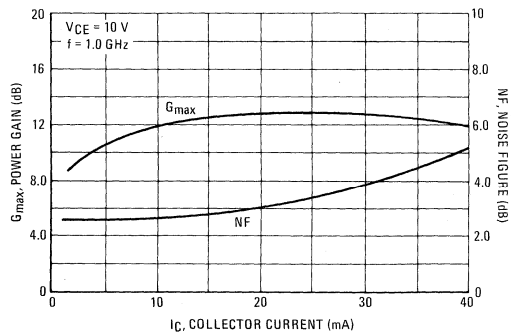


FIGURE 4 – S_{11} PARAMETERS

Frequency (MHz)		500		1000		1500		2000	
VCE (Volts)	IC (mA)	S ₁₁	$\angle \phi$	S ₁₁	$\angle \phi$	S ₁₁	$\angle \phi$	S ₁₁	$\angle \phi$
5.0	2.0	0.66	-125	0.64	-175	0.68	160	0.73	140
	5.0	0.57	-150	0.58	170	0.62	150	0.66	135
	10	0.54	-165	0.57	160	0.60	145	0.64	130
	20	0.54	-180	0.57	155	0.60	140	0.64	125
	30	0.54	175	0.57	155	0.61	140	0.65	125
10	2.0	0.66	-120	0.63	-170	0.67	160	0.71	140
	5.0	0.56	-145	0.56	175	0.60	150	0.64	135
	10	0.51	-160	0.53	165	0.57	145	0.61	130
	20	0.49	-175	0.52	160	0.57	145	0.60	130
	30	0.49	-175	0.53	160	0.57	145	0.61	130

FIGURE 5 – S_{22} PARAMETERS

Frequency (MHz)		500		1000		1500		2000	
VCE (Volts)	IC (mA)	S ₂₂	$\angle \phi$	S ₂₂	$\angle \phi$	S ₂₂	$\angle \phi$	S ₂₂	$\angle \phi$
5.0	2.0	0.61	45	0.50	-60	0.48	-80	0.50	-100
	5.0	0.40	-55	0.31	-65	0.30	-85	0.32	-100
	10	0.27	-60	0.20	-70	0.20	-90	0.23	-105
	20	0.19	-70	0.13	-75	0.14	-95	0.17	-110
	30	0.16	-70	0.11	-75	0.13	-95	0.16	-110
10	2.0	0.66	-35	0.55	-50	0.53	-70	0.54	-90
	5.0	0.47	-45	0.38	-50	0.37	-70	0.38	-75
	10	0.35	-45	0.28	-50	0.27	-65	0.29	-85
	20	0.26	-45	0.22	-50	0.22	-65	0.24	-80
	30	0.25	-40	0.21	-45	0.22	-60	0.24	-80

FIGURE 6 – S_{21} PARAMETERS

Frequency (MHz)		500		1000		1500		2000	
VCE (Volts)	IC (mA)	S ₂₁	$\angle \phi$	S ₂₁	$\angle \phi$	S ₂₁	$\angle \phi$	S ₂₁	$\angle \phi$
5.0	2.0	3.24	100	1.84	70	1.23	50	0.96	35
	5.0	4.85	90	2.60	70	1.76	50	1.38	40
	10	5.78	85	3.04	70	2.05	50	1.61	40
	20	6.40	85	3.30	65	2.23	50	1.24	40
	30	6.47	80	3.35	65	2.26	50	1.76	40
10	2.0	3.42	100	1.95	70	1.31	50	1.01	35
	5.0	5.20	95	2.80	70	1.89	50	1.45	40
	10	6.22	90	3.28	70	2.20	55	1.71	40
	20	6.82	85	3.55	65	2.37	55	1.84	40
	30	6.90	85	3.55	65	2.36	50	1.81	40

FIGURE 7 – S_{12} PARAMETERS

Frequency (MHz)		500		1000		1500		2000	
VCE (Volts)	IC (mA)	S ₁₂	$\angle \phi$	S ₁₂	$\angle \phi$	S ₁₂	$\angle \phi$	S ₁₂	$\angle \phi$
5.0	2.0	0.11	30	0.12	25	0.11	35	0.13	50
	5.0	0.08	40	0.10	45	0.13	55	0.17	55
	10	0.07	50	0.10	55	0.14	60	0.19	60
	20	0.06	60	0.11	65	0.15	65	0.20	60
	30	0.06	65	0.11	65	0.15	65	0.20	60
10	2.0	0.10	35	0.10	30	0.10	40	0.12	55
	5.0	0.07	40	0.09	45	0.12	55	0.15	60
	10	0.06	50	0.09	55	0.13	60	0.17	60
	20	0.06	60	0.10	65	0.13	65	0.18	60
	30	0.06	60	0.10	65	0.14	65	0.18	65

MRF914

The RF Line

2

NPN SILICON HIGH FREQUENCY TRANSISTOR

... designed for applications requiring high-gain, low-noise and low distortion. Also excellent for high speed switching applications.

- Low Noise Figure —
NF = 2.0 dB (Typ) @ f = 0.5 GHz
= 2.5 dB (Typ) @ f = 1.0 GHz
- High Power Gain —
G_{max} = 15 dB (Typ) @ f = 0.5 GHz
= 10 dB (Typ) @ f = 1.0 GHz

$$f_T = 4.5 \text{ GHz @ } 20 \text{ mA}$$

**HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



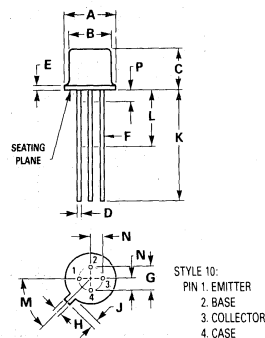
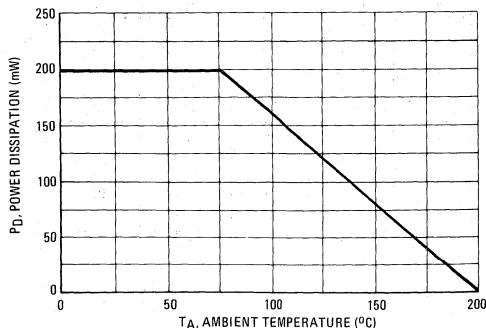
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	12	Vdc
Collector-Base Voltage	V _{CBO}	20	Vdc
Emitter-Base Voltage	V _{EBO}	2.0	Vdc
Collector Current — Peak	I _C	40	mA dc
Total Device Dissipation @ T _A = 75°C Derate Above 75°C	P _D	200 1.6	mW mW/°C
Storage Temperature Range	T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	R _{θJA}	625	°C/W

FIGURE 1 — POWER DERATING



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

**CASE 20-03
TO-206AF
(TO-72)**

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 1.0 mA, I _B = 0)	V _{(BR)CEO}	12	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 0.1 mA, I _E = 0)	V _{(BR)CBO}	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 0.1 mA, I _C = 0)	V _{(BR)EBO}	2.0	—	—	Vdc
Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0)	I _{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I _C = 20 mA, V _{CE} = 10 Vdc)	h _{FE}	30	—	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I _C = 20 mA, V _{CE} = 10 Vdc, f = 0.5 GHz)	f _T	—	4.5	—	GHz
Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz)	C _{cb}	—	0.7	1.0	pF
FUNCTIONAL TESTS					
Noise Figure (I _C = 5.0 mA, V _{CE} = 10 Vdc, f = 0.5 GHz) (I _C = 5.0 mA, V _{CE} = 10 Vdc, f = 1.0 GHz)	NF	— —	2.0 2.5	— —	dB
Power Gain at Optimum Noise Figure (I _C = 5.0 mA, V _{CE} = 10 Vdc, f = 0.5 GHz) (I _C = 5.0 mA, V _{CE} = 10 Vdc, f = 1.0 GHz)	G _{NF}	— —	12 7.0	— —	dB
Maximum Available Power Gain (1) (I _C = 20 mA, V _{CE} = 10 Vdc, f = 0.5 GHz) (I _C = 20 mA, V _{CE} = 10 Vdc, f = 1.0 GHz)	G _{max}	— —	15 10	— —	dB

$$(1) G_{\max} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

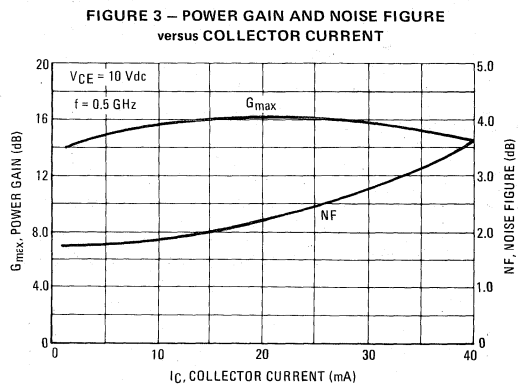
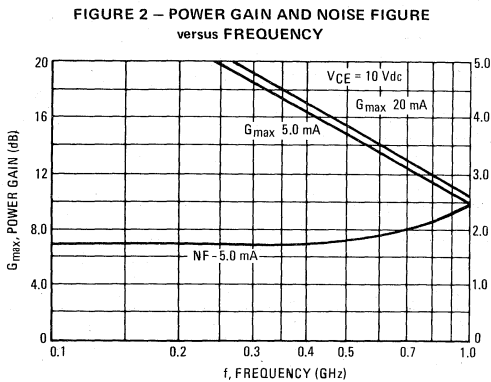


FIGURE 4 – S₁₁ PARAMETERS

Frequency (MHz)		100		300		500		700		1000	
V _{CE} (Volts)	I _C (mA)	S ₁₁	∠φ	S ₁₁	∠φ	S ₁₁	∠φ	S ₁₁	∠φ	S ₁₁	∠φ
5.0	2.0	0.84	-35	0.57	-80	0.42	-115	0.34	-140	0.27	-166
	5.0	0.65	-45	0.34	-85	0.23	-115	0.18	-130	0.16	-150
	10	0.48	-50	0.32	-85	0.14	-105	0.12	-115	0.09	-120
	20	0.33	-50	0.15	-75	0.10	-90	0.09	-100	0.09	-101
	30	0.27	-50	0.13	-70	0.09	-85	0.09	-100	0.09	-101
10	2.0	0.86	-30	0.59	-75	0.42	-105	0.34	-130	0.25	-155
	5.0	0.70	-40	0.37	-75	0.24	-95	0.18	-110	0.13	-125
	10	0.55	-45	0.26	-70	0.17	-80	0.14	-90	0.13	-90
	20	0.41	-45	0.21	-60	0.15	-65	0.13	-75	0.14	-80
	30	0.36	-45	0.19	-55	0.14	-65	0.13	-75	0.13	-80

FIGURE 5 – S₂₂ PARAMETERS

Frequency (MHz)		100		300		500		700		1000	
V _{CE} (Volts)	I _C (mA)	S ₂₂	∠φ	S ₂₂	∠φ	S ₂₂	∠φ	S ₂₂	∠φ	S ₂₂	∠φ
5.0	2.0	0.94	-15	0.77	-25	0.68	-30	0.66	-35	0.64	-45
	5.0	0.85	-20	0.63	-30	0.57	-30	0.55	-35	0.55	-45
	10	0.75	-25	0.55	-25	0.51	-30	0.50	-35	0.50	-40
	20	0.66	-25	0.50	-25	0.47	-30	0.47	-35	0.48	-40
	30	0.62	-25	0.49	-25	0.46	-25	0.46	-30	0.47	-40
10	2.0	0.95	-10	0.81	-20	0.74	-30	0.72	-35	0.71	-40
	5.0	0.87	-15	0.69	-25	0.64	-25	0.63	-30	0.63	-40
	10	0.80	-20	0.63	-20	0.59	-25	0.59	-30	0.60	-40
	20	0.72	-20	0.59	-20	0.57	-23	0.57	-30	0.58	-35
	30	0.70	-20	0.59	-20	0.57	-20	0.57	-30	0.58	-35

FIGURE 6 – S₂₁ PARAMETERS

Frequency (MHz)		100		300		500		700		1000	
V _{CE} (Volts)	I _C (mA)	S ₂₁	∠φ	S ₂₁	∠φ	S ₂₁	∠φ	S ₂₁	∠φ	S ₂₁	∠φ
5.0	2.0	5.99	150	4.06	110	2.90	90	2.27	75	1.71	55
	5.0	11.38	135	5.91	100	3.90	80	2.93	70	2.17	55
	10	15.21	125	6.78	95	4.34	80	3.23	70	2.38	55
	20	17.98	115	7.27	90	4.58	75	3.40	65	2.50	50
	30	18.78	110	7.37	85	4.64	75	3.42	65	2.50	50
10	2.0	6.05	150	4.20	115	3.04	90	2.37	75	1.75	55
	5.0	11.46	135	6.17	100	4.06	85	3.08	70	2.26	55
	10	15.45	127	7.08	95	4.56	80	3.41	70	2.50	55
	20	18.35	120	7.57	90	4.80	75	3.58	65	2.61	55
	30	19.12	115	7.63	90	4.79	75	3.56	65	2.60	55

FIGURE 7 – S₁₂ PARAMETERS

Frequency (MHz)		100		300		500		700		1000	
V _{CE} (Volts)	I _C (mA)	S ₁₂	∠φ	S ₁₂	∠φ	S ₁₂	∠φ	S ₁₂	∠φ	S ₁₂	∠φ
5.0	2.0	0.04	70	0.09	50	0.11	50	0.12	50	0.16	50
	5.0	0.04	70	0.07	60	0.11	60	0.14	60	0.19	55
	10	0.03	70	0.07	70	0.11	65	0.15	65	0.20	55
	20	0.03	75	0.07	70	0.12	70	0.15	65	0.21	55
	30	0.03	75	0.07	70	0.12	70	0.16	65	0.21	57
10	2.0	0.03	70	0.07	55	0.09	50	0.10	50	0.13	55
	5.0	0.03	70	0.06	60	0.09	65	0.12	60	0.15	60
	10	0.03	70	0.06	65	0.09	65	0.12	65	0.17	60
	20	0.03	75	0.06	70	0.09	70	0.13	65	0.18	60
	30	0.03	75	0.06	70	0.10	70	0.13	65	0.17	60

MRF931

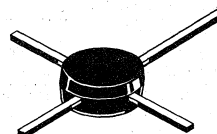
The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

... designed primarily for use in low-power amplifiers to 1.0 GHz. Ideal for pagers and other battery operated systems where low-power consumption is critical.

- Low-Power Consumption Characterized for $I_E = 0.1$ to 1.0 mA
- High Current-Gain — Bandwidth Product — $f_T = 3.0$ GHz (Typ)
- Stripline Design for Optimum Performance

LOW CURRENT
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



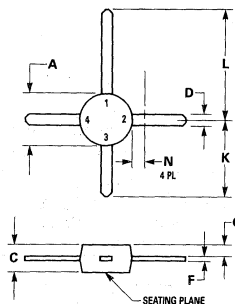
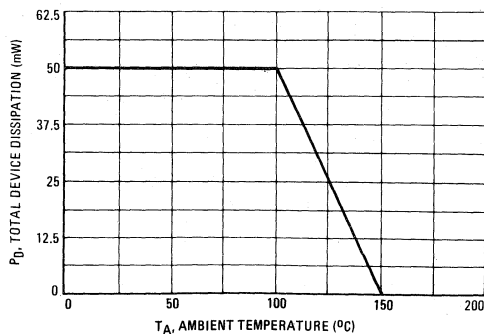
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	5.0	Vdc
Collector-Base Voltage	V_{CBO}	10	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Peak	I_C	5.0	mA dc
Total Device Dissipation @ $T_A = 100^\circ\text{C}$ Derate Above 100°C	P_D	50	mW
		1.0	mW/ $^\circ\text{C}$
Junction Temperature	T_J	+150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	500	$^\circ\text{C/W}$

FIGURE 1 — POWER DERATING



STYLE 2:
 PIN 1. COLLECTOR
 2. EMITTER
 3. BASE
 4. EMITTER

NOTE:
 DIMENSION D NOT APPLICABLE IN ZONE N.

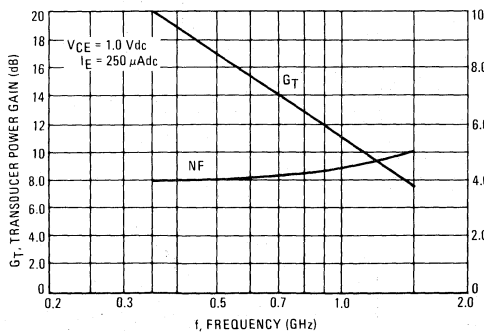
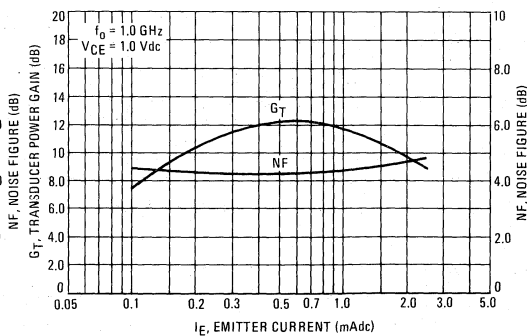
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	5.0	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.01\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	10	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 0.25\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$)	h_{FE}	30	—	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product ($I_E = 1.0\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$, $f = 1.0\text{ GHz}$)	f_T	—	3.0	—	GHz
Collector-Base Capacitance ($V_{CB} = 1.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{cb}	—	0.35	0.5	pF
FUNCTIONAL TESTS					
Noise Figure ($I_E = 0.25\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$, $f = 0.5\text{ GHz}$) ($I_E = 0.25\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$, $f = 1.0\text{ GHz}$)	NF	— —	3.8 4.3	— —	dB
Power Gain at Optimum Noise Figure ($I_E = 0.25\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$, $f = 0.5\text{ GHz}$) ($I_E = 0.25\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$, $f = 1.0\text{ GHz}$)	G_{NF}	— —	16 10	— —	dB
Transducer Power Gain ($I_E = 0.5\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$, $f = 0.5\text{ GHz}$) ($I_E = 0.5\text{ mA}$, $V_{CE} = 1.0\text{ Vdc}$, $f = 1.0\text{ GHz}$)	G_T	— —	18 12	— —	dB

TYPICAL CHARACTERISTICS

FIGURE 2 — TRANSDUCER POWER GAIN AND NOISE
FIGURE versus FREQUENCYFIGURE 3 — TRANSDUCER POWER GAIN AND NOISE
FIGURE versus EMITTER CURRENT

The RF Line

NPN Silicon

Low Noise, High-Frequency Transistors

... designed for use in high gain, low noise small-signal amplifiers. This series features excellent broadband linearity and is offered in a variety of packages.

- Fully Implanted Base and Emitter Structure
- 9 Finger, 1.25 Micron Geometry with Gold Top Metal
- Gold Sintered Back Metal
- Tape and Reel Packaging Options Available
- Surface Mount Packages Available in Both Standard and Low Profiles

MAXIMUM RATINGS

Ratings	Symbol	MRF941	MMBR941	MRF9411,L	Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	1.5	1.5	Vdc
Power Dissipation ⁽¹⁾ $T_A = 25^\circ\text{C}$	P_D	0.4	0.4	0.4	Watts
Collector Current — Continuous ⁽²⁾	I_C	50	50	50	mA
Maximum Junction Temperature	T_{Jmax}	150	150	150	$^\circ\text{C}$
Storage Temperature	T_{stg}	-65 to +150	-65 to +150	-65 to +150	$^\circ\text{C}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	312	312	312	$^\circ\text{C/W}$

DEVICE MARKING

MMBR941 = 7Y
MRF9411,L = 10

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS⁽³⁾					
Collector-Emitter Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	20	23	—	Vdc
Emitter Cutoff Current ($V_{EB} = 1\text{ V}$, $I_C = 0$)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current ($V_{CB} = 10\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS⁽³⁾					
DC Current Gain ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{cb}	—	0.35	—	pF
Current Gain — Bandwidth Product ($V_{CE} = 6\text{ V}$, $I_C = 15\text{ mA}$, $f = 1\text{ GHz}$)	f_T	—	8	—	GHz

NOTES: 1. To calculate the junction temperature use $T_J = P_D \times R_{\theta JA} + T_{AMBIENT}$.
2. I_C — Continuous (MTBF ≈ 10 years)
3. Pulse width $\leq 300\text{ }\mu\text{s}$, duty cycle $\leq 2\%$ pulsed.

MRF941
MMBR941
MRF9411,L

$I_C = 50\text{ mA}$
LOW NOISE
HIGH FREQUENCY
TRANSISTORS



CASE 317-01, STYLE 2
MACRO-X
MRF941



CASE 318-05, STYLE 6
SOT-23
MMBR941



CASE 318B-03, STYLE 1
SOT-143
MRF9411,L

PERFORMANCE CHARACTERISTICS

Conditions	Symbol	MRF941			MRF9411,L			MMBR941,L			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Insertion Gain ($V_{CE} = 6\text{ V}$, $I_C = 15\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 15\text{ mA}$, $f = 2\text{ GHz}$)	$|S_{21}|^2$	—	16	—	—	16	—	—	14	—	dB
Maximum Unilateral Gain ⁽¹⁾ ($V_{CE} = 6\text{ V}$, $I_C = 15\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 15\text{ mA}$, $f = 2\text{ GHz}$)	$G_{U\text{ max}}$	—	18	—	—	18	—	—	16	—	dB
Noise Figure ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 2\text{ GHz}$)	NF_{opt}	—	1.3	—	—	1.3	—	—	1.3	—	dB
Associated Gain at Minimum ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 2\text{ GHz}$)	G_{NF}	—	15	—	—	15	—	—	14	—	dB
Noise Figure ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	$NF_{50\Omega}$	—	1.9	2.8	—	1.9	2.8	—	1.9	2.8	dB

NOTE: 1. Maximum Unilateral Gain is $G_{U\text{ max}} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$

TYPICAL CHARACTERISTICS

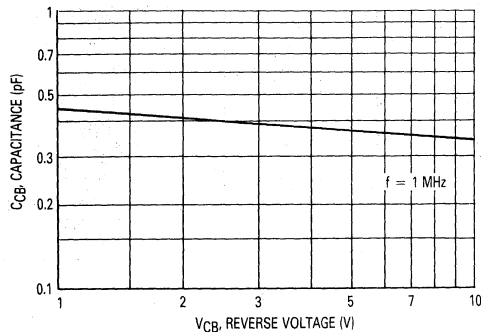


Figure 1. Collector-Base Capacitance versus Voltage

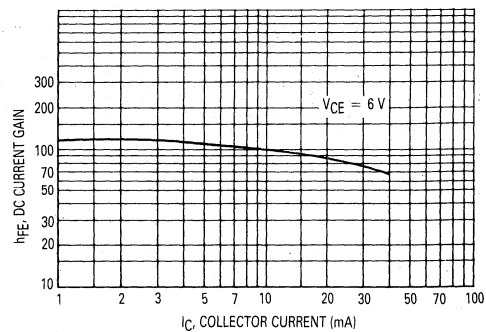


Figure 2. DC Current Gain versus Collector Current

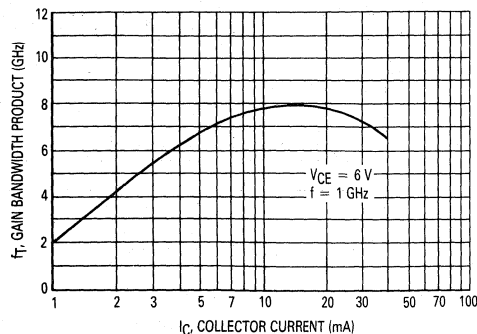


Figure 3. Gain Bandwidth Product versus Collector Current

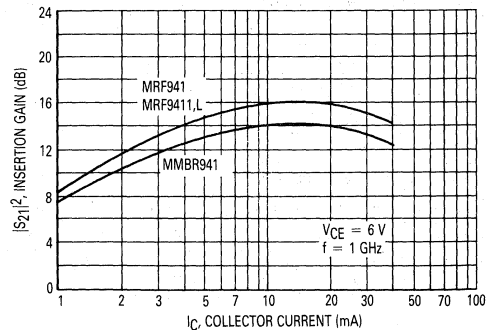


Figure 4. Insertion Gain versus Collector Current

FORWARD INSERTION GAIN AND
MAXIMUM UNILATERAL GAIN versus FREQUENCY

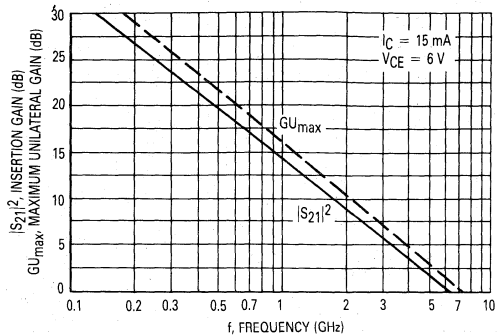


Figure 5. MMBR941

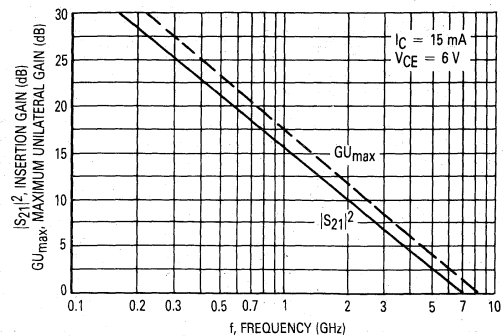


Figure 6. MRF941, MRF9411,L

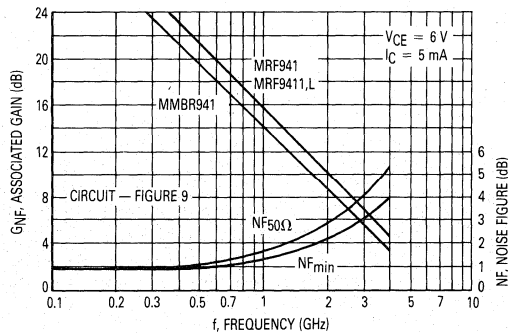


Figure 7. Noise Figure and Associated Gain
versus Frequency

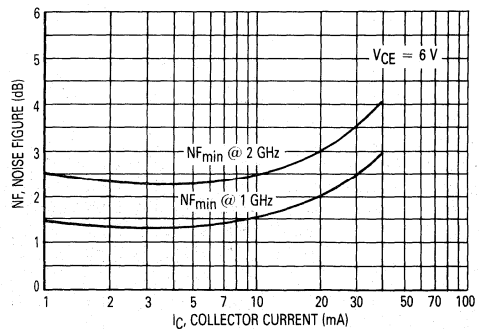


Figure 8. Noise Figure versus Collector Current

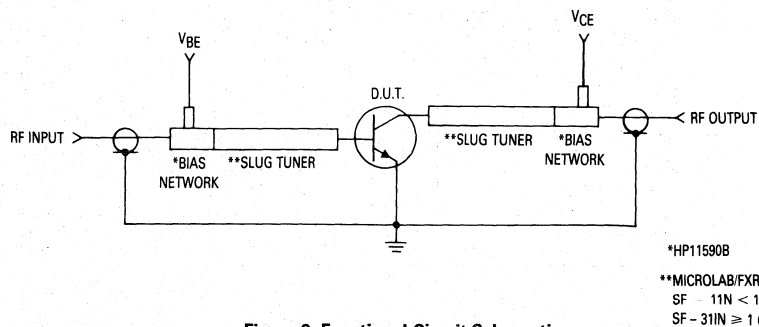


Figure 9. Functional Circuit Schematic

MRF941
COMMON EMITTER S-PARAMETERS

VCE (Volts)	IC (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
6	5	100	0.82	-24	14.5	162	0.02	81	0.96	-11
		200	0.77	-47	13.2	147	0.03	68	0.89	-21
		400	0.62	-84	10.3	124	0.04	53	0.73	-33
		600	0.54	-110	8.1	108	0.06	49	0.63	-39
		800	0.46	-131	6.4	98	0.06	49	0.58	-44
		1000	0.42	-148	5.3	90	0.07	52	0.55	-46
		1500	0.36	177	3.6	74	0.09	56	0.51	-53
		2000	0.34	145	2.7	61	0.11	59	0.50	-61
		2500	0.36	118	2.2	51	0.14	60	0.49	-69
		3000	0.42	90	1.9	44	0.16	56	0.46	-75
		3500	0.51	77	1.7	35	0.22	53	0.41	-90
		4000	0.58	58	1.6	28	0.23	47	0.37	-100
		5000	0.72	44	1.5	9	0.26	33	0.39	-151
		6000	0.86	35	1.4	-14	0.30	24	0.55	167
	10	100	0.67	-37	24.4	154	0.02	88	0.91	-17
		200	0.48	-67	20	135	0.02	55	0.79	-29
		400	0.45	-111	13.4	112	0.03	56	0.59	-37
		600	0.40	-136	9.8	99	0.04	57	0.50	-41
		800	0.44	-155	7.5	90	0.06	61	0.47	-43
		1000	0.35	-170	6.1	84	0.06	62	0.45	-44
		1500	0.31	159	4.1	70	0.08	66	0.45	-50
		2000	0.32	130	3.1	59	0.11	66	0.44	-58
		2500	0.34	107	2.4	50	0.15	65	0.44	-66
		3000	0.41	82	2.1	43	0.17	59	0.41	-71
		3500	0.49	72	1.9	35	0.21	54	0.36	-85
		4000	0.55	54	1.7	27	0.23	46	0.33	-93
		5000	0.68	42	1.6	10	0.27	32	0.32	-144
		6000	0.82	34	1.5	-12	0.30	23	0.48	-169
	15	100	0.57	-47	30.1	149	0.02	63	0.87	-20
		200	0.48	-83	23.2	128	0.02	64	0.72	-31
		400	0.40	-126	14.4	107	0.03	65	0.52	-37
		600	0.36	-150	10.2	95	0.04	65	0.46	-39
		800	0.34	-167	7.8	87	0.05	66	0.43	-42
		1000	0.33	180	6.3	81	0.06	67	0.42	-42
		1500	0.27	151	4.2	69	0.08	72	0.43	-49
		2000	0.32	124	3.1	59	0.12	69	0.42	-56
		2500	0.34	103	2.5	49	0.15	67	0.42	-64
		3000	0.41	80	2.1	42	0.17	59	0.40	-69
		3500	0.49	70	1.9	34	0.20	54	0.35	-84
		4000	0.55	52	1.7	27	0.28	47	0.32	-90
		5000	0.68	41	1.7	9	0.26	33	0.31	-143
		6000	0.82	33	1.5	-13	0.29	23	0.46	169
	30	100	0.41	-74	37.8	139	0.01	69	0.79	-24
		200	0.37	-116	25.8	118	0.01	65	0.62	-32
		400	0.37	-152	14.7	100	0.02	72	0.47	-32
		600	0.36	-170	10.1	90	0.03	70	0.43	-33
		800	0.35	176	7.7	83	0.04	71	0.42	-36
		1000	0.35	167	6.1	78	0.06	75	0.42	-38
		1500	0.34	142	4.1	65	0.08	72	0.44	-44
		2000	0.36	118	3.1	55	0.11	71	0.43	-53
		2500	0.38	100	2.4	46	0.14	68	0.44	-62
		3000	0.45	77	2.1	40	0.17	61	0.42	-68
		3500	0.53	68	1.8	32	0.21	58	0.37	-82
		4000	0.59	51	1.6	25	0.24	48	0.34	-92
		5000	0.72	40	1.5	7	0.26	34	0.33	-143
		6000	0.85	31	1.4	-15	0.30	24	0.48	171

MMBR941
COMMON EMITTER S-PARAMETERS

V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
6	5	100	0.82	-25	14.6	159	0.02	77	0.94	-13
		200	0.75	-47	12.6	142	0.04	68	0.85	-22
		400	0.55	-79	9.2	120	0.05	61	0.69	-31
		600	0.42	-98	6.9	106	0.07	60	0.60	-32
		800	0.33	-114	5.3	97	0.08	61	0.56	-33
		1000	0.28	-129	4.5	90	0.09	62	0.52	-33
		1500	0.25	-155	3.1	77	0.13	67	0.51	-37
		2000	0.16	176	2.4	66	0.16	68	0.51	-36
		2500	0.21	151	2	57	0.20	69	0.48	-40
		3000	0.18	122	1.7	50	0.23	68	0.48	-44
		3500	0.30	108	1.5	42	0.27	66	0.45	-46
		4000	0.29	91	1.4	37	0.32	64	0.42	-53
	10	100	0.67	-37	23.5	149	0.02	74	0.88	-18
		200	0.54	-64	18.1	129	0.03	68	0.73	-28
		400	0.37	-96	11.3	108	0.05	67	0.56	-31
		600	0.26	-114	8	98	0.06	67	0.50	-30
		800	0.21	-130	6	91	0.08	70	0.47	-30
		1000	0.18	-147	5.1	85	0.09	70	0.45	-30
		1500	0.18	-167	3.4	74	0.13	72	0.46	-34
		2000	0.11	159	2.6	64	0.17	71	0.46	-34
		2500	0.17	140	2.2	56	0.21	69	0.44	-38
		3000	0.15	107	1.8	59	0.25	67	0.45	-41
		3500	0.27	100	1.7	42	0.28	65	0.42	-42
		4000	0.26	85	1.5	37	0.33	61	0.39	-49
	15	100	0.56	-46	28.6	143	0.02	73	0.83	-22
		200	0.43	-75	20.2	122	0.03	67	0.65	-30
		400	0.29	-107	11.8	104	0.04	70	0.50	-30
		600	0.22	-125	8.2	95	0.06	74	0.46	-28
		800	0.18	-141	6.2	88	0.08	74	0.45	-27
		1000	0.16	-158	5.1	83	0.09	74	0.43	-28
		1500	0.17	-174	3.4	72	0.13	73	0.44	-32
		2000	0.11	150	2.6	63	0.17	72	0.45	-33
		2500	0.17	138	2.2	55	0.21	70	0.43	-37
		3000	0.15	102	1.9	49	0.25	67	0.44	-39
		3500	0.28	98	1.7	42	0.29	65	0.40	-41
		4000	0.25	82	1.5	37	0.32	61	0.38	-47
	20	100	0.49	-52	31.5	139	0.01	70	0.79	-23
		200	0.36	-84	21.1	118	0.02	69	0.60	-29
		400	0.25	-115	12.1	101	0.04	73	0.48	-29
		600	0.20	-134	8.3	93	0.06	74	0.45	-26
		800	0.16	-150	6.2	87	0.07	75	0.44	-26
		1000	0.15	-166	5.1	82	0.09	75	0.42	-26
		1500	0.16	-176	3.5	75	0.14	74	0.44	-31
		2000	0.12	144	2.6	63	0.17	73	0.45	-32
		2500	0.17	133	2.2	55	0.22	70	0.43	-36
		3000	0.16	101	1.9	49	0.25	68	0.44	-39
		3500	0.28	98	1.6	41	0.29	65	0.41	-40
		4000	0.26	82	1.5	36	0.33	61	0.39	-47
	30	100	0.41	-65	34.3	134	0.01	70	0.74	-25
		200	0.30	-99	21.6	113	0.02	70	0.56	-28
		400	0.23	-131	11.9	98	0.04	76	0.47	-25
		600	0.20	-147	8.1	91	0.06	76	0.45	-24
		800	0.18	-163	6.1	84	0.07	78	0.44	-23
		1000	0.17	-177	5	80	0.09	78	0.43	-24
		1500	0.18	174	3.4	70	0.13	76	0.45	-30
		2000	0.14	141	2.5	61	0.17	74	0.47	-31
		2500	0.20	131	2.1	54	0.21	71	0.45	-36
		3000	0.18	104	1.8	47	0.25	69	0.46	-39
		3500	0.31	100	1.6	40	0.29	65	0.42	-42
		4000	0.29	84	1.5	35	0.33	62	0.40	-48

MRF9411,L
COMMON EMITTER S-PARAMETERS

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			Mag	$\angle \phi$	Mag	$\angle \phi$	Mag	$\angle \phi$	Mag	$\angle \phi$
6	5	100	0.73	-24	14	164	0.02	92	0.96	-11
		200	0.74	-47	12.9	150	0.03	65	0.90	-20
		400	0.66	-83	10.4	129	0.05	56	0.75	-32
		600	0.62	-108	8.4	115	0.06	45	0.65	-40
		800	0.56	-127	6.7	105	0.07	46	0.60	-43
		1000	0.54	-141	5.6	96	0.07	51	0.57	-46
		1500	0.46	-166	3.9	82	0.08	55	0.52	-50
		2000	0.43	172	2.9	70	0.09	56	0.50	-54
		2500	0.41	151	2.3	62	0.11	61	0.48	-60
		3000	0.44	128	1.9	55	0.14	62	0.49	-65
		3500	0.49	117	1.6	47	0.15	61	0.46	-74
		4000	0.57	101	1.4	42	0.16	62	0.47	-81
		5000	0.60	92	1.2	32	0.21	60	0.46	-105
		6000	0.58	88	1	20	0.25	61	0.51	-137
	10	100	0.64	-39	23.6	157	0.01	59	0.91	-16
		200	0.60	-71	20	139	0.02	70	0.80	-27
		400	0.54	-112	13.9	117	0.03	57	0.61	-39
		600	0.52	-135	10.3	104	0.04	50	0.51	-43
		800	0.49	-151	8	96	0.05	54	0.46	-44
		1000	0.47	-161	6.5	89	0.06	60	0.46	-46
		1500	0.41	177	4.4	77	0.08	62	0.44	-47
		2000	0.40	158	3.2	67	0.09	65	0.43	-52
		2500	0.39	139	2.6	60	0.11	68	0.41	-56
		3000	0.44	118	2.1	53	0.13	69	0.43	-62
		3500	0.49	110	1.8	47	0.15	67	0.39	-72
		4000	0.54	96	1.6	42	0.18	65	0.41	-78
		5000	0.63	88	1.3	32	0.23	61	0.40	-101
		6000	0.58	86	1.1	20	0.26	62	0.44	-136
	15	100	0.56	-51	29.5	152	0.01	78	0.87	-20
		200	0.53	-88	23.5	131	0.02	63	0.73	-31
		400	0.51	-128	15.1	111	0.03	63	0.54	-40
		600	0.49	-148	11.8	99	0.04	56	0.46	-42
		800	0.48	-161	8.3	92	0.04	59	0.42	-41
		1000	0.46	-170	6.7	86	0.05	59	0.41	-44
		1500	0.41	-171	4.4	75	0.07	70	0.42	-45
		2000	0.40	152	3.3	66	0.09	71	0.41	-50
		2500	0.39	135	2.6	59	0.11	71	0.41	-55
		3000	0.45	116	2.2	53	0.14	73	0.42	-61
		3500	0.50	108	1.9	46	0.17	70	0.39	-70
		4000	0.55	94	1.6	41	0.19	67	0.41	-76
		5000	0.61	87	1.3	32	0.22	62	0.34	-114
		6000	0.58	85	1.1	21	0.27	63	0.43	-135
	30	100	0.45	-82	36.3	142	0.01	62	0.79	-23
		200	0.48	-121	25.5	121	0.01	48	0.62	-31
		400	0.49	-152	14.6	103	0.02	58	0.47	-33
		600	0.50	-166	10.2	93	0.03	60	0.44	-34
		800	0.49	-175	7.7	87	0.04	65	0.42	-34
		1000	0.48	177	6.1	81	0.05	76	0.43	-37
		1500	0.45	162	4.1	71	0.07	75	0.45	-39
		2000	0.45	145	3	62	0.09	78	0.44	-46
		2500	0.44	130	2.4	56	0.11	79	0.44	-53
		3000	0.50	113	1.9	50	0.13	79	0.45	-58
		3500	0.55	105	1.6	43	0.15	75	0.44	-70
		4000	0.61	92	1.5	39	0.19	73	0.45	-76
		5000	0.65	84	1.2	30	0.24	68	0.43	-100
		6000	0.61	82	1	19	0.28	64	0.48	-135

The RF Line
NPN Silicon
Low Noise, High-Frequency
Transistors

... designed for use in high gain, low noise small-signal amplifiers. This series features excellent broadband linearity and is offered in a variety of packages.

- Fully Implanted Base and Emitter Structure
- 18 Finger, 1.25 Micron Geometry with Gold Top Metal
- Gold Sintered Back Metal
- Tape and Reel Packaging Options Available
- Surface Mount Packages Available in Both Standard and Low Profiles

MAXIMUM RATINGS

Ratings	Symbol	MRF951	MMBR951,L	MRF9511,L	Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	1.5	1.5	Vdc
Power Dissipation ⁽¹⁾	P_D	1	0.58	0.5	Watts
Collector Current — Continuous ⁽²⁾	I_C	100	100	100	mA
Maximum Junction Temperature	T_{Jmax}	150	150	150	°C
Storage Temperature	T_{stg}	-65 to +150	-65 to +150	-65 to +150	°C
Thermal Resistance, Junction to Case	$R_{\theta JC}$	100	130	130	°C/W

DEVICE MARKING

MRF9511,L = 11

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS⁽³⁾					
Collector-Emitter Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	10	13	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	20	25	—	Vdc
Emitter Cutoff Current ($V_{EB} = 1\text{ V}$, $I_C = 0$)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current ($V_{CB} = 10\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS⁽³⁾					
DC Current Gain ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{cb}	—	0.45	—	pF
Current Gain ⁽⁴⁾ — Bandwidth Product ($V_{CE} = 8\text{ V}$, $I_C = 30\text{ mA}$, $f = 1\text{ GHz}$)	f_T	—	8	—	GHz

NOTES: 1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package. To calculate the junction temperature use $T_J = P_D \times R_{\theta JC} + T_{CASE}$.

2. I_C — Continuous (MTBF ≈ 10 years)

3. Pulse width $\leq 300\text{ }\mu\text{s}$, duty cycle $\leq 2\%$ pulsed.

MRF951
MMBR951
MRF9511,L

$I_C = 100\text{ mA}$
LOW NOISE
HIGH FREQUENCY
TRANSISTORS


CASE 317-01, STYLE 2
MACRO-X
MRF951


CASE 318-05, STYLE 6
SOT-23
MMBR951


CASE 318B-03, STYLE 1
SOT-143
MRF9511,L

PERFORMANCE CHARACTERISTICS

Conditions	Symbol	MRF951			MRF9511,L			MMBR951,L			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Insertion Gain ($V_{CE} = 8\text{ V}$, $I_C = 30\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 8\text{ V}$, $I_C = 30\text{ mA}$, $f = 2\text{ GHz}$)	$|S_{21}|^2$	—	14.5 9.5	—	—	14.5 9	—	—	12.5 7	—	dB
Maximum Unilateral Gain ⁽¹⁾ ($V_{CE} = 8\text{ V}$, $I_C = 30\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 8\text{ V}$, $I_C = 30\text{ mA}$, $f = 2\text{ GHz}$)	$G_{U\max}$	—	17 11	—	—	17 10.5	—	—	14 8	—	dB
Noise Figure ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 2\text{ GHz}$)	NF_{opt}	—	1.3 2.1	—	—	1.3 2.1	—	—	1.3 2.1	—	dB
Associated Gain at Minimum ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$) ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 2\text{ GHz}$)	G_{NF}	—	14 9	—	—	14 9	—	—	13 7.5	—	dB
Noise Figure ($V_{CE} = 6\text{ V}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	$NF_{50\Omega}$	—	1.9	2.8	—	1.9	2.8	—	1.9	2.8	dB

NOTE: 1. Maximum Unilateral Gain is $G_{U\max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

TYPICAL CHARACTERISTICS

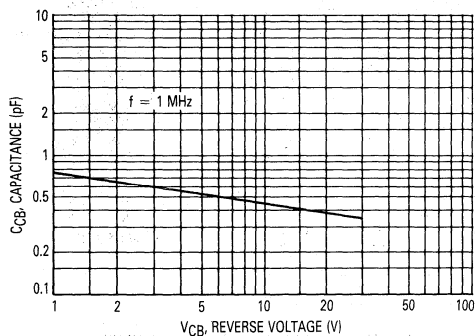


Figure 1. Typical Collector-Base Capacitance versus Voltage

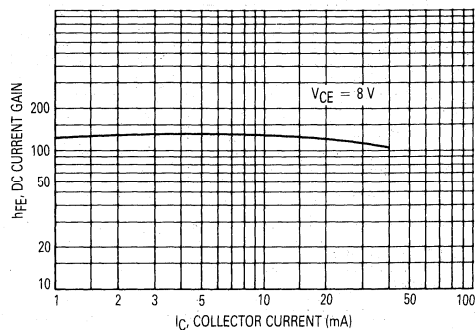


Figure 2. Typical DC Current Gain versus Collector Current

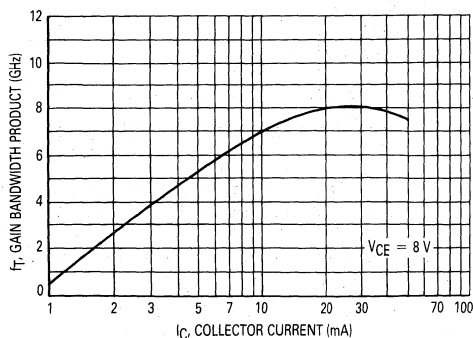


Figure 3. Typical Gain Bandwidth Product versus Collector Current

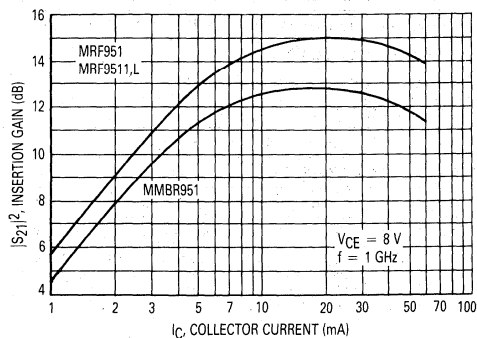


Figure 4. Typical Insertion Gain versus Collector Current

**TYPICAL FORWARD INSERTION GAIN AND
MAXIMUM UNILATERAL GAIN versus FREQUENCY**

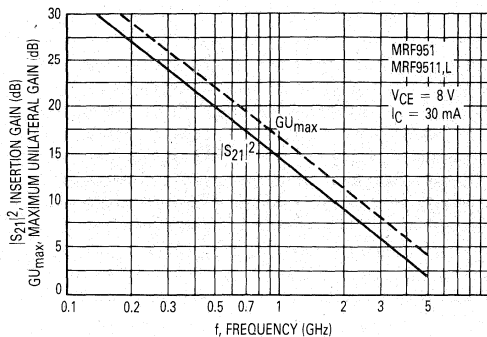


Figure 5. MRF951, MRF9511,L

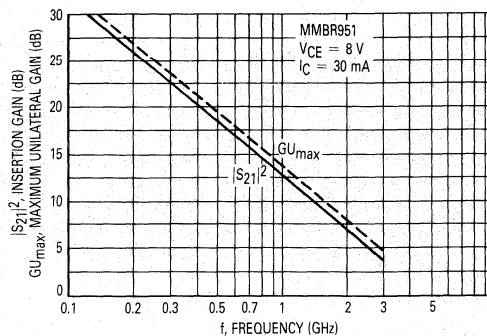


Figure 6. MMBR951,L

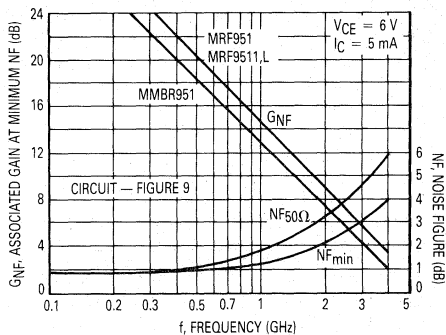


Figure 7. Typical Noise Figure and Associated Gain
versus Frequency

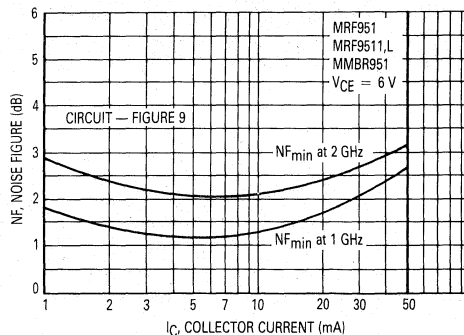


Figure 8. Typical Noise Figure
versus Collector Current

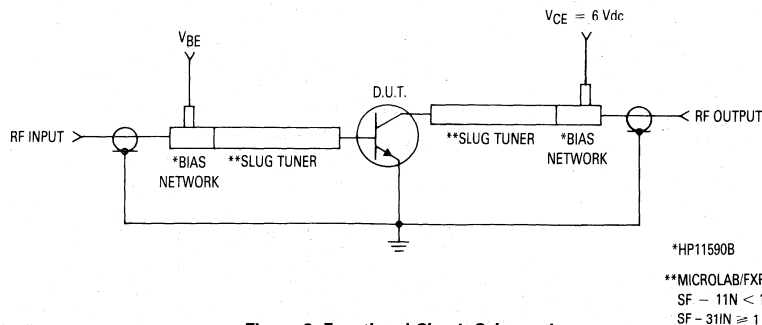


Figure 9. Functional Circuit Schematic

MRF951
TYPICAL COMMON EMITTER S-PARAMETERS

V _{CE} (V _{dc})	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
6	5	100	0.81	-36	13.89	156	0.03	72	0.94	-17
		500	0.58	-122	7.23	105	0.07	42	0.55	-46
		1000	0.53	-165	4.06	78	0.08	41	0.42	-57
		1500	0.54	172	2.78	61	0.10	44	0.40	-67
		2000	0.55	155	2.13	46	0.12	47	0.40	-79
		2500	0.56	140	1.74	32	0.15	48	0.41	-92
		3000	0.59	127	1.46	21	0.18	47	0.43	-105
		3500	0.61	115	1.28	9	0.22	44	0.45	-119
		4000	0.62	104	1.13	-1	0.26	40	0.48	-132
	10	100	0.67	-41	22.99	147	0.02	67	0.86	-26
		500	0.50	-85	8.94	97	0.05	49	0.41	-53
		1000	0.48	-34	4.75	75	0.08	54	0.31	-61
		1500	0.49	163	3.26	60	0.11	55	0.29	-71
		2000	0.51	148	2.47	46	0.14	53	0.30	-83
		2500	0.52	135	2.03	34	0.17	50	0.31	-97
		3000	0.55	123	1.72	22	0.20	46	0.34	-109
		3500	0.56	112	1.50	11	0.24	41	0.36	-122
		4000	0.59	101	1.33	1	0.28	37	0.39	-135
	20	100	0.52	-77	32.50	137	0.02	62	0.75	-34
		500	0.46	-96	10.00	92	0.05	60	0.30	-56
		1000	0.47	172	5.20	73	0.08	63	0.24	-63
		1500	0.48	156	3.50	59	0.11	61	0.24	-74
		2000	0.49	143	2.70	46	0.15	57	0.24	-86
		2500	0.51	131	2.20	34	0.18	52	0.26	-100
		3000	0.53	121	1.90	23	0.22	47	0.29	-112
		3500	0.55	110	1.60	13	0.25	41	0.31	-125
		4000	0.57	100	1.40	3	0.28	35	0.34	-137
	30	100	0.45	-95	36.80	132	0.02	64	0.68	-38
		500	0.46	-170	10.20	89	0.04	65	0.27	-55
		1000	0.47	169	5.30	72	0.08	66	0.22	-62
		1500	0.48	154	3.60	58	0.11	63	0.22	-73
		2000	0.50	142	2.80	45	0.15	58	0.23	-86
		2500	0.51	132	2.30	36	0.18	54	0.25	-97
		3000	0.53	119	1.90	23	0.22	47	0.28	-113
		3500	0.55	109	1.60	12	0.25	41	0.30	-125
		4000	0.57	99	1.50	2	0.29	35	0.33	-137
	60	100	0.41	-129	38.90	123	0.01	63	0.58	-40
		500	0.49	-35	9.70	86	0.04	71	0.26	-44
		1000	0.50	164	4.90	70	0.07	71	0.24	-53
		1500	0.52	151	3.30	56	0.11	67	0.24	-66
		2000	0.53	140	2.50	43	0.15	61	0.26	-79
		2500	0.55	128	2.10	31	0.18	56	0.28	-94
		3000	0.57	118	1.70	21	0.21	50	0.31	-108
		3500	0.59	108	1.50	10	0.25	44	0.33	-121
		4000	0.61	98	1.30	0	0.29	38	0.36	-134

(continued)

MRF951
TYPICAL COMMON EMITTER S-PARAMETERS (continued)

V _{CE} (Vdc)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
8	5	100	0.82	-34	13.71	157	0.03	74	0.94	-16
		500	0.59	-119	7.35	106	0.07	42	0.57	-44
		1000	0.52	-162	4.14	78	0.08	41	0.44	-54
		1500	0.52	174	2.86	61	0.10	46	0.41	-65
		2000	0.54	156	2.19	46	0.12	48	0.41	-76
		2500	0.55	141	1.78	32	0.15	50	0.42	-90
		3000	0.58	128	1.49	21	0.18	48	0.45	-103
		3500	0.59	116	1.31	9	0.22	45	0.47	-116
		4000	0.62	104	1.15	-1	0.26	41	0.50	-129
	10	100	0.68	-50	23.16	148	0.02	67	0.86	-24
		500	0.49	-142	9.19	98	0.05	50	0.43	-49
		1000	0.47	-177	4.87	75	0.07	54	0.33	-56
		1500	0.48	164	3.33	60	0.10	56	0.32	-66
		2000	0.50	149	2.56	46	0.13	54	0.32	-77
		2500	0.51	136	2.08	34	0.16	52	0.34	-91
		3000	0.54	124	1.76	23	0.20	48	0.36	-103
		3500	0.55	113	1.54	11	0.23	43	0.38	-117
		4000	0.58	103	1.36	1	0.27	39	0.41	-129
	20	100	0.53	-73	32.78	138	0.02	65	0.76	-32
		500	0.45	-160	10.25	92	0.04	60	0.33	-50
		1000	0.45	174	5.33	73	0.07	62	0.27	-57
		1500	0.46	161	3.96	62	0.10	61	0.26	-65
		2000	0.48	144	2.74	46	0.14	57	0.27	-79
		2500	0.50	132	2.24	34	0.17	54	0.29	-93
		3000	0.52	121	1.90	23	0.21	48	0.31	-106
		3500	0.54	111	1.66	12	0.24	42	0.33	-118
		4000	0.56	101	1.48	3	0.28	37	0.36	-131
	30	100	0.45	-90	37.27	132	0.01	62	0.70	-36
		500	0.45	-102	10.50	90	0.04	65	0.30	-48
		1000	0.45	170	5.41	72	0.07	66	0.25	-55
		1500	0.47	155	3.66	58	0.11	64	0.25	-66
		2000	0.48	142	2.81	46	0.14	59	0.26	-78
		2500	0.50	131	2.27	34	0.18	55	0.27	-92
		3000	0.52	120	1.93	23	0.21	49	0.30	-105
		3500	0.54	110	1.69	12	0.25	43	0.32	-118
		4000	0.56	100	1.50	2	0.28	38	0.35	-131
	60	100	0.42	-124	38.02	124	0.01	63	0.60	-35
		500	0.49	-106	9.54	87	0.04	70	0.31	-38
		1000	0.50	165	4.92	70	0.07	71	0.29	-47
		1500	0.51	152	3.36	57	0.10	68	0.29	-60
		2000	0.52	140	2.55	44	0.14	62	0.30	-74
		2500	0.54	129	2.08	32	0.17	58	0.32	-88
		3000	0.56	118	1.76	21	0.21	52	0.34	-102
		3500	0.58	108	1.53	10	0.24	46	0.37	-116
		4000	0.61	98	1.35	0	0.28	40	0.39	-129

MMBR951
COMMON EMITTER S-PARAMETERS

V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
6	5	100	0.82	-36.6	14.0	153	0.04	44.7	0.88	-18.2
		500	0.50	-119	6.6	104	0.07	48.2	0.52	-40
		1000	0.39	-162	3.5	81	0.11	55	0.43	-43
		2000	0.32	150	1.9	57	0.21	66	0.42	-50
		3000	0.36	110	1.4	40	0.31	66	0.40	-67
	10	100	0.66	-54	22.6	142	0.03	60	0.78	-29
		500	0.38	-138	7.8	96	0.07	55	0.40	-42
		1000	0.32	-176	4.0	78	0.13	71	0.34	-47
		2000	0.26	142	2.2	57	0.22	70	0.36	-46
		3000	0.31	105	1.6	41	0.32	64	0.33	-62
	20	100	0.49	-76	30	131	0.01	85	0.67	-37
		500	0.32	-153	8.3	92	0.08	76	0.34	-39
		1000	0.29	175	4.3	77	0.11	67	0.29	-44
		2000	0.24	137	2.3	57	0.24	71	0.32	-48
		3000	0.28	102	1.6	42	0.34	63	0.29	-60
	30	100	0.40	-94	33	125	0.03	87	0.58	-42
		500	0.30	-162	8.4	90	0.07	84	0.31	-35
		1000	0.29	170	4.3	76	0.12	80	0.27	-39
		2000	0.24	134	2.3	56	0.23	71	0.33	-48
		3000	0.30	101	1.6	41	0.35	66	0.30	-60
	60	100	0.38	-126	31	116	0.03	74	0.49	-37
		500	0.37	-176	7.3	77.6	0.05	84	0.34	-26
		1000	0.36	163	3.7	73.4	0.12	84	0.34	-37
		2000	0.33	130	2.0	52	0.22	78	0.37	-48
		3000	0.38	98	1.4	37	0.34	69	0.34	-62
8	5	100	0.83	-35	13.9	154	0.04	92	0.90	-19
		500	0.51	-117	6.7	104	0.08	51	0.55	-38
		1000	0.38	-160	3.6	82	0.10	72	0.44	-42
		2000	0.31	151	1.9	58	0.20	73	0.46	-47
		3000	0.35	110	1.4	41	0.32	71	0.43	-63
	10	100	0.67	-52	23	143	0.02	96	0.81	-28
		500	0.37	-135	7.9	97	0.07	64	0.43	-38
		1000	0.30	-173	4.1	80	0.11	78	0.37	-41
		2000	0.25	143	2.2	57	0.21	74	0.38	-47
		3000	0.30	105	1.6	42	0.31	67	0.34	-60
	20	100	0.51	-72	30	131	0.02	68	0.68	-35
		500	0.31	-150	8.5	92	0.07	75	0.36	-36
		1000	0.28	177	4.3	77	0.13	76	0.32	-39
		2000	0.23	138	2.3	57	0.22	72	0.35	-45
		3000	0.27	103	1.6	42	0.31	64	0.31	-58
	30	100	0.42	-87	33	125	0.02	71	0.61	-38
		500	0.31	-159	8.6	90	0.07	71	0.33	-33
		1000	0.27	172	4.4	76	0.11	74	0.32	-39
		2000	0.23	135	2.3	57	0.22	73	0.34	-42
		3000	0.28	102	1.6	41	0.31	65	0.33	-55
	60	100	0.39	-119	32	117	0.02	31	0.52	-31
		500	0.36	-174	7.4	87	0.06	84	0.37	-25
		1000	0.35	164	3.8	74	0.11	78	0.35	-33
		2000	0.32	131	2.0	53	0.22	81	0.42	-41
		3000	0.37	100	1.4	38	0.33	70	0.40	-62

MRF9511,L
TYPICAL COMMON EMITTER S-PARAMETERS

V _{CE} (V _{dc})	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
6	5	100	0.81	-48	13.69	152	0.04	66	0.88	-22
		500	0.67	-122	7.58	92	0.07	41	0.57	-50
		1000	0.61	-157	4.65	76	0.09	40	0.45	-62
		1500	0.57	86	2.87	70	0.10	44	0.42	-71
		2000	0.54	156	2.14	60	0.12	52	0.42	-75
		2500	0.55	121	1.72	51	0.14	57	0.40	-86
		3000	0.57	121	1.48	44	0.17	59	0.39	-97
		3500	0.65	110	1.28	38	0.21	60	0.37	-112
		4000	0.67	100	1.14	33	0.24	54	0.38	-130
	10	100	0.71	-56	24.07	149	0.03	66	0.86	-28
		500	0.60	-143	9.47	101	0.05	46	0.41	-62
		1000	0.56	-176	4.97	81	0.07	51	0.30	-73
		1500	0.53	167	3.35	69	0.10	57	0.31	-78
		2000	0.50	148	2.54	60	0.13	63	0.30	-78
		2500	0.52	132	2.02	52	0.16	63	0.29	-89
		3000	0.54	116	1.75	45	0.19	61	0.29	-78
		3500	0.60	106	1.53	39	0.22	60	0.26	-115
		4000	0.64	97	1.35	34	0.26	57	0.28	-133
	20	100	0.59	-80	33.51	138	0.02	61	0.75	-38
		500	0.56	-159	10.39	95	0.04	54	0.31	-69
		1000	0.54	175	5.36	79	0.07	62	0.23	-79
		1500	0.51	161	3.58	68	0.10	66	0.25	-82
		2000	0.49	142	2.75	60	0.13	68	0.25	-80
		2500	0.52	128	2.18	52	0.16	66	0.23	-91
		3000	0.53	112	1.88	45	0.20	63	0.23	-99
		3500	0.60	103	1.65	39	0.24	62	0.21	-117
		4000	0.63	95	1.46	34	0.27	57	0.22	-137
	30	100	0.54	-97	37.48	133	0.02	57	0.67	-43
		500	0.56	-166	10.60	63	0.04	59	0.27	-70
		1000	0.54	171	5.45	78	0.07	68	0.21	-80
		1500	0.51	158	3.62	67	0.10	69	0.24	-81
		2000	0.50	140	2.73	60	0.13	70	0.23	-79
		2500	0.52	126	2.19	51	0.17	68	0.23	-90
		3000	0.53	111	1.89	45	0.20	64	0.23	-97
		3500	0.60	102	1.65	38	0.24	62	0.20	-115
		4000	0.63	94	1.47	33	0.27	58	0.22	-136
	60	100	0.54	-128	36.66	123	0.01	57	0.56	-43
		500	0.60	-177	8.97	89	0.03	67	0.27	-50
		1000	0.59	166	4.62	75	0.06	73	0.25	-59
		1500	0.56	153	3.05	64	0.09	75	0.29	-68
		2000	0.55	136	2.29	56	0.13	76	0.30	-71
		2500	0.57	125	1.85	48	0.16	74	0.29	-83
		3000	0.59	110	1.59	42	0.20	69	0.30	-92
		3500	0.65	102	1.41	36	0.23	67	0.27	-108
		4000	0.69	93	1.22	31	0.27	62	0.29	-130

(continued)

MRF9511,L
TYPICAL COMMON EMITTER S-PARAMETERS (continued)

VCE (Vdc)	IC (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
8	5	100	0.84	-36	14.65	158	0.03	72	0.94	-18
		500	0.68	-120	7.79	110	0.07	42	0.58	-48
		1000	0.60	-161	4.32	86	0.08	41	0.44	-60
		1500	0.56	88	2.95	71	0.10	45	0.44	-68
		2000	0.53	157	2.19	60	0.11	53	0.44	-71
		2500	0.55	140	1.76	51	0.14	58	0.42	-82
		3000	0.56	122	1.50	44	0.17	60	0.42	-92
		3500	0.63	112	1.33	39	0.18	62	0.38	-107
		4000	0.68	105	1.18	33	0.21	63	0.36	-125
	10	100	0.73	-53	24.04	150	0.02	68	0.87	-26
		500	0.60	-140	9.68	101	0.05	46	0.43	-58
		1000	0.55	-174	5.10	82	0.07	52	0.32	-66
		1500	0.52	169	3.42	69	0.09	58	0.33	-72
		2000	0.49	149	2.59	61	0.12	63	0.33	-73
		2500	0.51	133	2.06	52	0.15	63	0.32	-83
		3000	0.53	116	1.78	45	0.19	63	0.32	-91
		3500	0.64	109	1.60	38	0.20	62	0.28	-108
		4000	0.67	101	1.39	34	0.23	60	0.29	-131
	20	100	0.61	-76	33.76	139	0.02	60	0.76	-36
		500	0.56	-157	10.72	96	0.04	54	0.32	-63
		1000	0.53	176	5.53	79	0.07	62	0.29	-70
		1500	0.50	162	3.69	68	0.10	66	0.27	-75
		2000	0.48	143	2.79	60	0.13	68	0.27	-74
		2500	0.51	129	2.22	52	0.16	68	0.26	-84
		3000	0.52	112	1.92	46	0.19	65	0.26	-91
		3500	0.59	104	1.75	40	0.21	64	0.24	-109
		4000	0.63	98	1.54	35	0.24	59	0.25	-131
	30	100	0.57	-89	37.35	134	0.02	58	0.71	-40
		500	0.55	-163	10.82	94	0.04	57	0.29	-63
		1000	0.53	128	5.54	78	0.07	65	0.24	-69
		1500	0.50	159	3.69	67	0.10	69	0.26	-73
		2000	0.49	141	2.77	59	0.13	70	0.27	-71
		2500	0.51	127	2.23	51	0.16	69	0.26	-82
		3000	0.52	112	1.93	45	0.19	66	0.26	-89
		3500	0.61	106	1.68	40	0.21	64	0.21	-110
		4000	0.66	97	1.51	34	0.24	60	0.23	-130
	60	100	0.55	-122	34.92	126	0.01	52	0.59	-37
		500	0.59	-175	8.71	91	0.03	65	0.33	-42
		1000	0.58	167	4.52	76	0.06	73	0.30	-53
		1500	0.55	154	3.04	65	0.09	75	0.34	-62
		2000	0.54	138	2.28	56	0.12	77	0.35	-66
		2500	0.57	125	1.82	48	0.16	76	0.34	-78
		3000	0.59	110	1.56	42	0.19	72	0.35	-88
		3500	0.66	104	1.28	36	0.22	70	0.32	-105
		4000	0.70	95	1.14	32	0.26	66	0.32	-132

The RF Line

**N-Channel Dual-Gate GaAs
Field-Effect Transistor**

... depletion mode dual-gate MES FET designed for high frequency amplifier and mixer applications.

- Excellent Receiver Front End
- Low Noise Figure — NF = 1.2 dB, 1 GHz (Typ)
- High Power Gain — G_p = 17 dB, 1 GHz (Typ)
- Low Reverse Transfer Capacitance — C_{rss} = 40 fF (Typ)
- High Transconductance — g_m = 20 mS (Typ)
- Fully Characterized
- Gold Metallization

MAXIMUM RATINGS

Rating	Symbol	MRFC966	MRF966	Unit
Drain-Source Voltage	V_{DS}	10	10	Vdc
Gate-Source Voltage — Reverse	V_{G1S} V_{G2S}	-8 -8	-8 -8	Vdc
Gate-Source Voltage — Forward	V_{G1S} V_{G2S}	+1 +1	+1 +1	Vdc
Drain Current — Continuous	I_D	80	80	mAdc
Total Power Dissipation ($T_A = 25^\circ\text{C}$ Derate above 25°C)	P_D	350 $T_J = 125^\circ\text{C}$ Max	350 3.5	mW mW/ $^\circ\text{C}$
Storage Channel Temperature Range	T_{stg}	-65 to +125	-65 to +125	$^\circ\text{C}$
Junction Temperature Range	T_J	-65 to +125	-65 to +125	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Drain-Source Breakdown Voltage ($V_{G1S} = V_{G2S} = -4.5$ Vdc, $I_D = 100$ μA)	$V_{(BR)DSX}$	10	—	—	Vdc
Gate 1-to-Source Cutoff Voltage ($V_{DS} = 5$ Vdc, $V_{G2S} = 0$, $I_D = 500$ μA)	$V_{G1S(off)}$	-2	—	-4.5	Vdc
Gate 2-to-Source Cutoff Voltage ($V_{DS} = 5$ Vdc, $V_{G1S} = 0$, $I_D = 500$ μA)	$V_{G2S(off)}$	-2	—	-4.5	Vdc
Gate 1 Leakage Current ($V_{G1S} = -5$ Vdc, $V_{G2S} = V_{DS} = 0$)	I_{G1SS}	—	—	10	μAdc
Gate 2 Leakage Current ($V_{G2S} = -5$ Vdc, $V_{G1S} = V_{DS} = 0$)	I_{G2SS}	—	—	10	μAdc

ON CHARACTERISTICS

Zero-Gate Voltage Drain Current ($V_{DS} = 5$ Vdc, $V_{G1S} = V_{G2S} = 0$)	I_{DSS}	30	50	80	mAdc
--	-----------	----	----	----	------

SMALL-SIGNAL CHARACTERISTICS

Transconductance ($V_{DS} = 5$ Vdc, $V_{G2S} = 0$, $I_D = 10$ mA, $f = 1$ kHz)	g_m	18	20	—	mS
Input Capacitance ($V_{DS} = 5$ Vdc, $V_{G2S} = 0$, $I_D = 10$ mA, $f = 1$ MHz)	C_{iss}	—	1.5	—	pF
Reverse Transfer Capacitance ($V_{DS} = 5$ Vdc, $V_{G2S} = 0$, $I_D = 10$ mA, $f = 1$ MHz)	C_{rss}	—	0.04	—	pF

Handling and Packaging — MES devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MES devices should be observed.

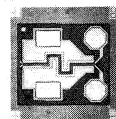
(continued)

**MRF966
MRFC966**

**N-CHANNEL
DUAL-GATE
GaAs FIELD-EFFECT
TRANSISTOR**



**MRF966
CASE 317-01, STYLE 1**



**CHIP
MRFC966**

ELECTRICAL CHARACTERISTICS — continued ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS					
Noise Figure(1) ($V_{DS} = 5\text{ Vdc}$, $V_{G2S} = 0$, $I_{DS} = 10\text{ mA}$, $f = 1\text{ GHz}$)	NF	—	1.2	1.5	dB
Common Source Power Gain(1) ($V_{DS} = 5\text{ Vdc}$, $V_{G2S} = 0$, $I_{DS} = 10\text{ mA}$, $f = 1\text{ GHz}$)	G_{PS}	15	17	—	dB
Intermodulation Distortion ($V_{DS} = 5\text{ Vdc}$, $I_{DS} = 10\text{ mA}$, $f_1 = 995\text{ MHz}$, $f_2 = 1001\text{ MHz}$, $V_{G2} = 0$, $P_{in} = -40\text{ dBm}$)	IMD ₃	—	-65	—	dB
Linear Power Point(2) ($V_{DS} = 5\text{ Vdc}$, $I_{DS} = 10\text{ mA}$, $f_1 = 995\text{ MHz}$, $f_2 = 1001\text{ MHz}$, $V_{G2} = 0$)	P_L	—	+1	—	dBm
Output Power at 1 dB Compression Point ($V_{DS} = 5\text{ Vdc}$, $I_{DS} = 10\text{ mA}$, $f = 1\text{ GHz}$)	P_{out}	—	10	—	dBm

NOTES:

1. Data taken using a 50 Ω test fixture, Microlab SF31N slug tuners, HP11590B bias networks and the HP8970A or Eaton 2075 noise figure meter.
Note: $V_{G2S} = 0$. Refer to Figure 11.
2. The linear power point is the output power level at which either the signal $2f_1 \pm f_2$ or $2f_2 \pm f_1$ are 30 dB below f_1 or f_2 .

TYPICAL CHARACTERISTICS

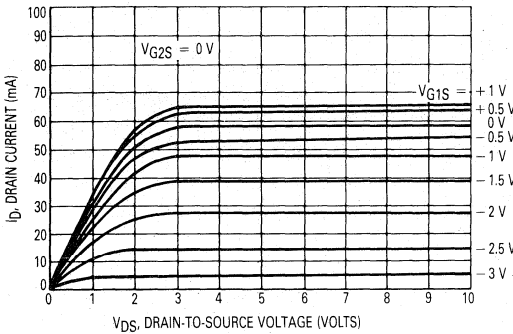


Figure 1. Drain Current versus Drain-To-Source Voltage

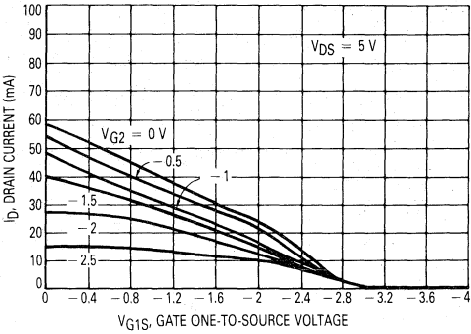


Figure 2. Drain Current versus Gate One-To-Source Voltage

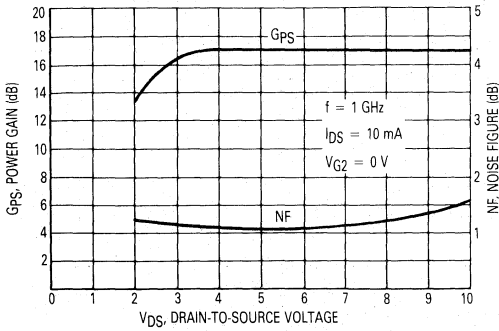


Figure 3. Power Gain and Noise Figure versus Drain-To-Source Voltage

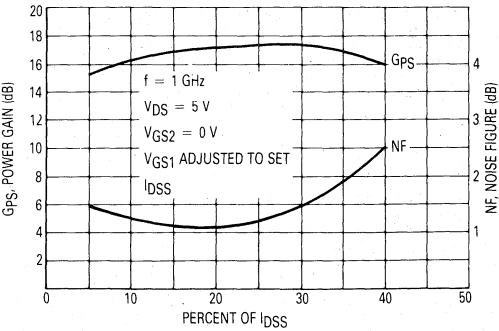


Figure 4. Power Gain and Noise Figure versus Percent of I_{DSS}

TYPICAL CHARACTERISTICS

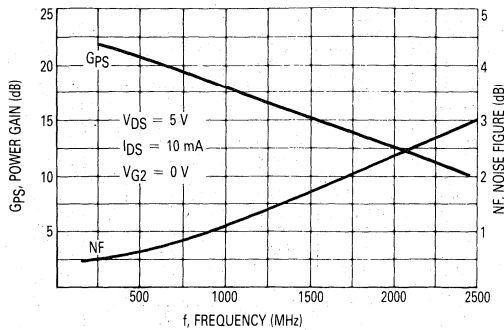


Figure 5. Power Gain and Noise Figure versus Frequency

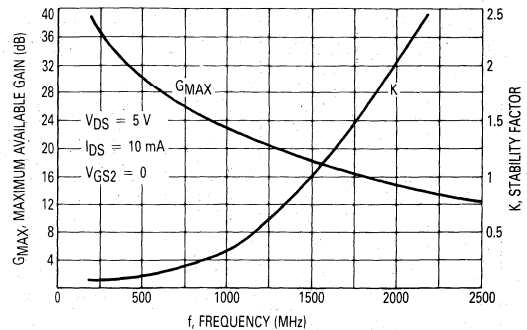


Figure 6. Maximum Available Gain and Stability Factor versus Frequency

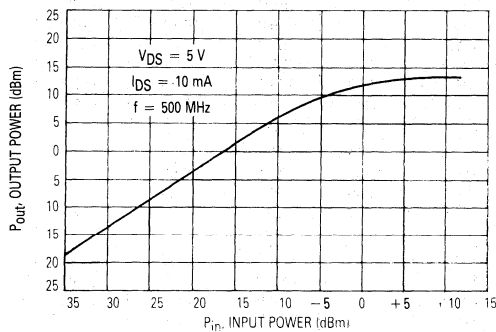


Figure 7. Output Power versus Input Power @ 500 MHz

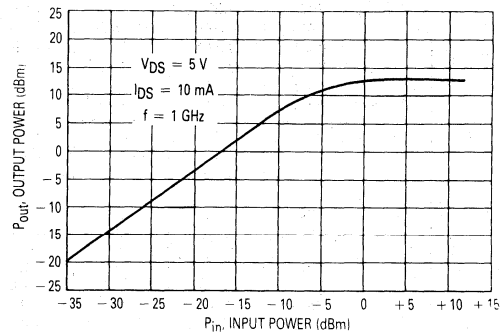


Figure 8. Output Power versus Input Power @ 1 GHz

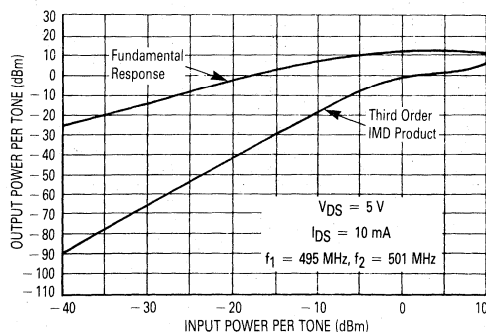


Figure 9. Third Order Intermodulation Distortion @ 500 MHz

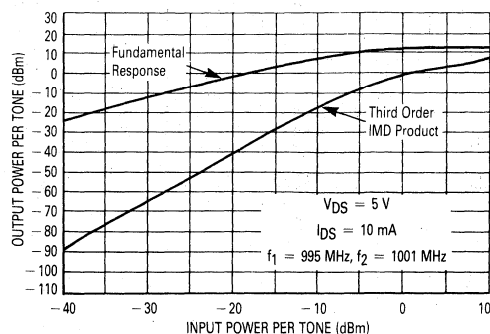


Figure 10. Third Order Intermodulation Distortion @ 1 GHz

COMMON SOURCE S-PARAMETERS

V _{DS} (Volts)	I _{DS} (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
3	5	200	0.997	-5.7	1.251	172.1	0.003	88.3	0.944	-6.4
		500	0.983	-14.3	1.23	161.2	0.007	84.6	0.931	-16
		1000	0.941	-28.3	1.201	142.4	0.013	78.5	0.9	-32.2
		1500	0.866	-42.3	1.133	122	0.016	70.4	0.836	-49.6
		2000	0.762	-55.4	1.011	101.1	0.018	56.2	0.744	-67.5
		2500	0.642	-66.4	0.819	77.4	0.015	25.5	0.608	-87.5
	10	200	0.995	-6.2	1.60	172.0	0.002	84.1	0.93	-6.3
		500	0.981	-15.1	1.58	161.3	0.007	82.5	0.92	-15.8
		1000	0.928	-29.9	1.55	142.9	0.013	81.5	0.90	-31.8
		1500	0.838	-44.4	1.46	122.3	0.016	74.7	0.84	-49.4
		2000	0.716	-57.7	1.31	101.2	0.018	60.1	0.76	-68.4
		2500	0.584	-67.5	1.06	77.4	0.015	26.7	0.63	-89.8
	15	200	0.996	-6.3	1.83	172.0	0.002	76.4	0.93	-6.3
		500	0.979	-15.7	1.80	161.2	0.006	91.5	0.92	-15.6
		1000	0.921	-30.9	1.76	142.3	0.012	82.3	0.90	-31.6
		1500	0.820	-45.9	1.66	121.7	0.016	76.1	0.85	-49.1
		2000	0.689	-58.7	1.48	100.6	0.016	64.1	0.77	-68.2
		2500	0.552	-67.4	1.20	76.7	0.013	28.9	0.65	-90.3
	20	200	0.995	-6.5	1.97	171.9	0.003	85.7	0.92	-6.2
		500	0.977	-16.2	1.93	160.7	0.007	89.0	0.91	-15.3
		1000	0.910	-32.0	1.89	141.7	0.011	84.0	0.89	-31.0
		1500	0.804	-47.1	1.79	120.9	0.016	78.3	0.85	-48.4
		2000	0.669	-59.7	1.59	99.6	0.017	66.2	0.78	-67.4
		2500	0.531	-67.7	1.29	75.8	0.012	32.7	0.66	-89.2
5	5	200	0.997	-5.8	1.27	172.8	0.002	102.6	0.97	-3.8
		500	0.983	-14.3	1.26	162.6	0.004	82.3	0.97	-9.4
		1000	0.939	-28.4	1.24	146.0	0.006	93.4	0.96	-18.8
		1500	0.866	-42.6	1.21	128.4	0.008	102.6	0.95	-28.3
		2000	0.765	-5.3	1.14	111.6	0.007	137.7	0.93	-37.6
		2500	0.642	-68.4	1.05	93.1	0.012	-179.0	0.92	-47.0
	10	200	0.966	-6.0	1.61	172.8	0.002	88.1	0.97	-3.8
		500	0.982	-15.1	1.59	162.8	0.004	85.8	0.97	-9.4
		1000	0.928	-29.9	1.57	146.1	0.006	94.6	0.96	-18.6
		1500	0.841	-44.6	1.53	128.7	0.006	110.4	0.94	-28.0
		2000	0.724	-58.3	1.42	111.6	0.008	152.6	0.93	-37.0
		2500	0.589	-69.4	1.30	93.3	0.014	179.1	0.92	-46.3
	15	200	0.997	-6.2	1.82	172.6	0.001	103.2	0.97	-3.7
		500	0.979	-15.6	1.80	162.5	0.003	85.3	0.96	-9.3
		1000	0.920	-30.8	1.77	145.6	0.005	92.4	0.95	-18.4
		1500	0.824	-45.8	1.72	127.9	0.007	116.3	0.94	-27.3
		2000	0.699	-59.2	1.59	110.8	0.008	154.1	0.93	-36.3
		2500	0.560	-69.6	1.44	92.6	0.017	176.2	0.92	-45.4
	20	200	0.995	-6.5	1.96	172.4	0.002	85.9	0.97	-3.7
		500	0.977	-16.1	1.93	162.1	0.004	80.9	0.96	-9.1
		1000	0.913	-31.7	1.90	144.9	0.005	92.1	0.95	-17.9
		1500	0.810	-47.0	1.83	126.9	0.007	121.4	0.94	-26.9
		2000	0.679	-60.4	1.69	109.7	0.009	153.4	0.93	-35.6
		2500	0.538	-70.0	1.53	91.4	0.017	176.0	0.93	-44.6

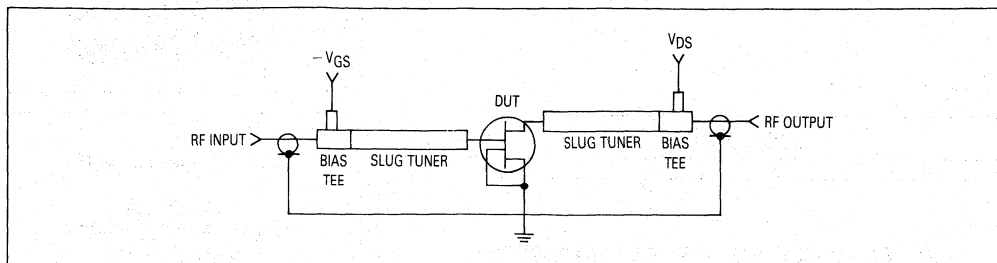
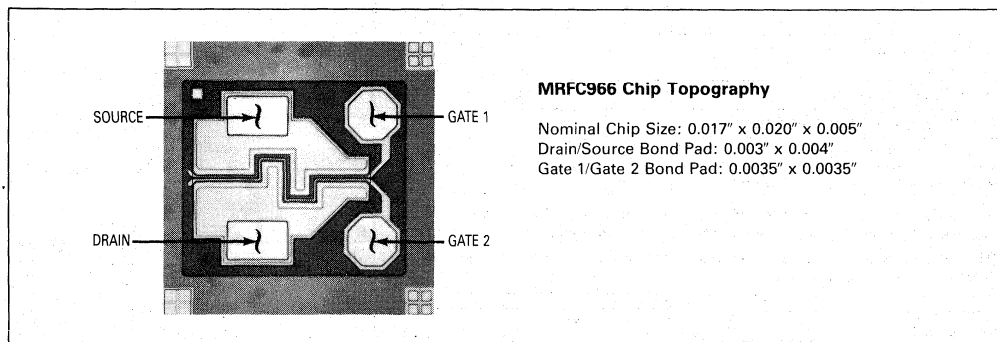


Figure 11. 1 GHz Test Circuit Schematic

TYPICAL CHARACTERISTICS

f (MHz)	G _{NF} (dB)	NF (dB)	$\Gamma_{MS} NF_{opt}$	$\Gamma_{ML} NF_{opt}$
450	20	0.6	0.82 / 21°	0.80 / 11°
1000	17	1.2	0.74 / 21°	0.77 / 12°

Figure 12. Source and Load Impedance for Optimum Noise Figure



The RF Line

MICROWAVE PULSE POWER TRANSISTORS

... designed for Class A and AB *common emitter* amplifier applications in the low-power stages of IFF, DME, TACAN, radar transmitters, and CW systems.

- Guaranteed Performance @ 1090 MHz, 18 Vdc — Class A Output Power = 0.2 Watt Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1000M Types
- Internal Input Matching for Broadband Operation

MAXIMUM RATINGS

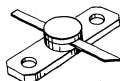
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	200	mA _{dc}
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	7.0 40	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

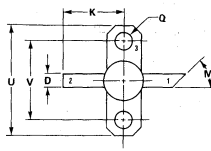
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	$^\circ\text{C}/\text{W}$

- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF1000MC CASE 361A-01



STYLE 2:
PIN 1. COLLECTOR
2. BASE
3. EMITTER



- NOTES:
1. DIMENSIONS R AND U ARE DATUMS AND T IS A DATUM SURFACE AND SEATING PLANE.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
[+/-] 0.38 (0.015) [0] [T] [U] [R] [0]
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	4.44	5.20	0.175	0.205
C	2.36	2.71	0.093	0.107
D	1.39	1.77	0.055	0.070
E	2.66	3.42	0.105	0.135
F	0.10	0.15	0.004	0.006
G	11.04	—	0.435	—
H	3.04	34.2	0.120	0.135
I	0.09	0.66	0.004	0.026
J	20.06	26.57	0.790	0.810
K	14.27	BSG	0.562	BSG

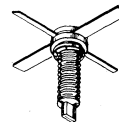
MRF1000MA MRF1000MB MRF1000MC

0.7 W 960-1215 MHz

CLASS A/AB MICROWAVE POWER TRANSISTORS

NPN SILICON

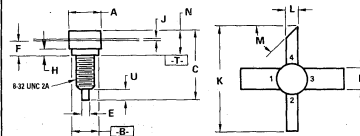
MRF1000MA CASE 332-04



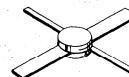
STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

- NOTES:
1. DIM [B] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
[+/-] 0.76 (0.030) [0] [T] [B] [0]
3. [T] IS SEATING PLANE.
4. DIMENSION K APPLIES TWO PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.206
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM	45° NOM	—	—
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

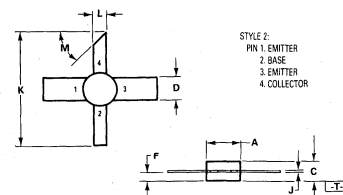


MRF1000MB CASE 332A-01



- NOTES:
1. DIM [A] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
[+/-] 0.76 (0.030) [0] [T] [A] [0]
3. [T] IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	6.86	7.34	0.270	0.290
B	3.30	3.81	0.130	0.150
C	4.95	5.21	0.195	0.206
D	1.40	1.76	0.055	0.070
E	1.40	1.76	0.055	0.070
F	0.08	0.18	0.003	0.007
G	15.24	—	0.600	—
H	2.41	2.67	0.095	0.105
I	45° NOM	45° NOM	—	—



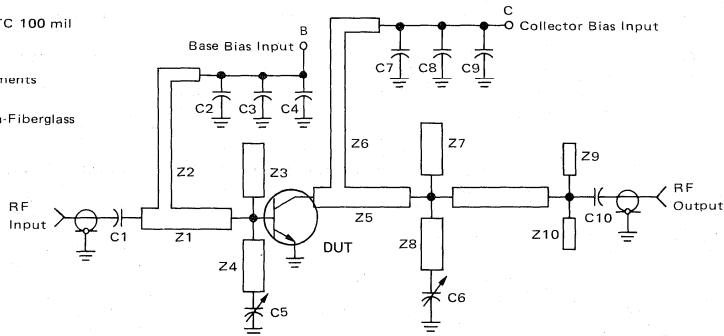
STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

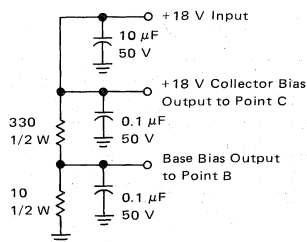
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 20\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	2.0	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Power Gain — Class A ($V_{CE} = 18\text{ Vdc}$, $I_C = 100\text{ mA}$, $f = 1090\text{ MHz}$, $P_{out} = 200\text{ mW}$)	G_{PE}	10	12	—	dB
Common-Emitter Power Gain — Class AB ($V_{CE} = 18\text{ Vdc}$, $I_{CQ} = 10\text{ mA}$, $f = 1090\text{ MHz}$, $P_{out} = 0.7\text{ W}$)	G_{PE}	—	10.7	—	dB
Load Mismatch — Class A ($V_{CE} = 18\text{ Vdc}$, $I_C = 100\text{ mA}$, $f = 1090\text{ MHz}$, $P_{out} = 200\text{ mW}$, $V_{SWR} = 10:1$ All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 1090 MHz TEST CIRCUIT

C1, C2, C3, C7, C8, C10 — 220 pF ATC 100 mil
 C4, C9 — 4.7 μF 50 V Tantalum
 C5, C6 — 0.8 - 8 pF Johanson #7290
 Z1-Z10 — Distributed Microstrip Elements
 — See Figure 8
 Board Material — 0.031" Thick Teflon-Fiberglass
 $\epsilon_r = 2.56$



Class AB Bias Control Circuit
 18 V Output I_{CQ} 10 mA Nominal



Class A Constant Current Bias Control Circuit
 $I_C = 100\text{ mA}$, $V_{CE} = 18\text{ V}$.

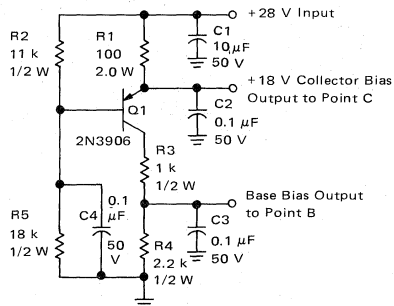


FIGURE 2 – OUTPUT POWER versus INPUT POWER

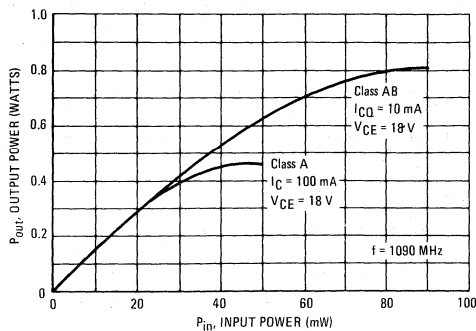


FIGURE 3 – OUTPUT POWER versus FREQUENCY

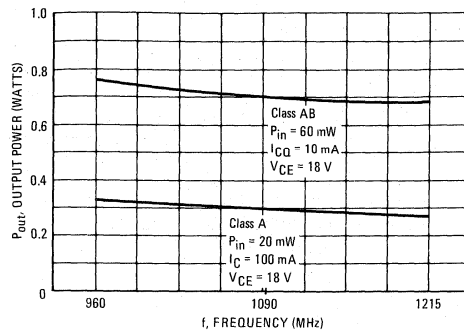


FIGURE 4 – DC SAFE OPERATING AREA

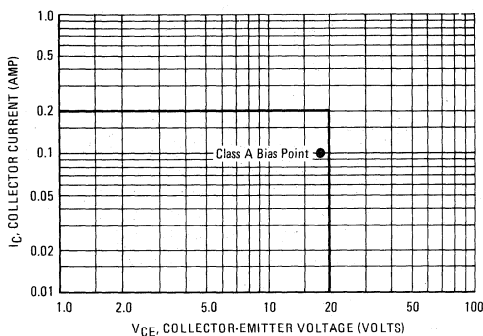


FIGURE 5 – POWER GAIN versus FREQUENCY

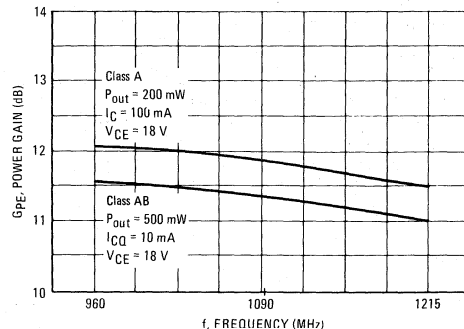
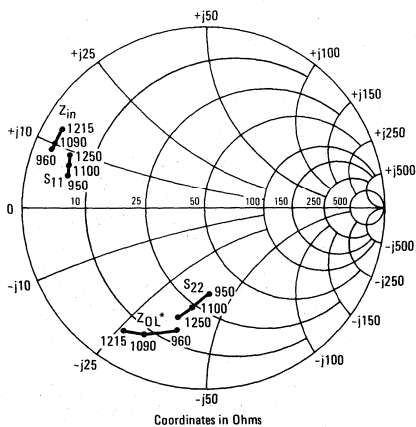


FIGURE 6 – COMMON-EMITTER S-PARAMETERS AND SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



SERIES EQUIVALENT IMPEDANCES

P_{out} = 0.5 W, V_{CE} = 18 Vdc,
I_{CQ} = 10 mA, Class AB

f MHz	Z _{in} Ohms	Z _{OL} * Ohms
960	3.0 + j9.0	16 - j40
1090	3.2 + j10	8.5 - j31
1215	2.8 + j12	7.0 - j26

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

S-PARAMETERS – V_{CE} = 18 Vdc, I_C = 100 mA, Class A

f	S ₁₁	S ₂₁	S ₁₂	S ₂₂
MHz	|S ₁₁|	|S ₂₁|	|S ₁₂|	|S ₂₂|
950	0.77	166	0.016	0.48
1000	0.78	165	0.016	0.50
1050	0.77	163	0.016	0.51
1100	0.77	162	0.016	0.54
1150	0.78	161	0.015	0.57
1200	0.78	159	0.016	0.59
1250	0.78	158	0.016	0.61

MRF1000MA, MRF1000MB, MRF1000MC

FIGURE 7 — 1090 MHz TEST AMPLIFIER

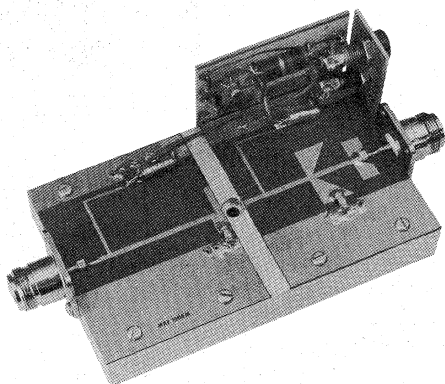
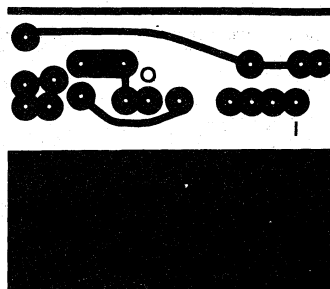
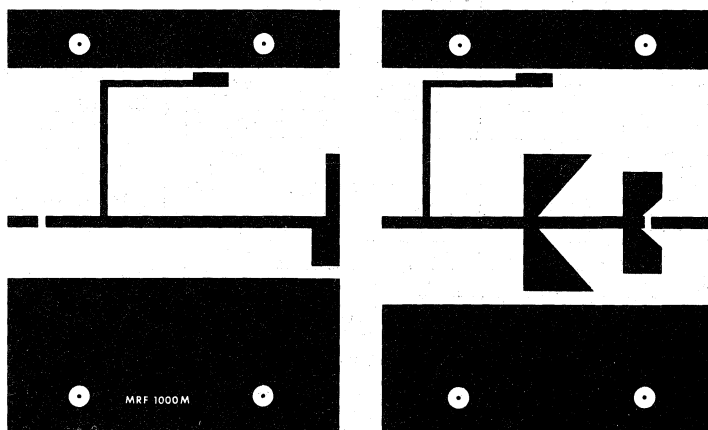


FIGURE 8 — PRINTED CIRCUIT BOARD
LAYOUT — 1090 MHz TEST CIRCUIT

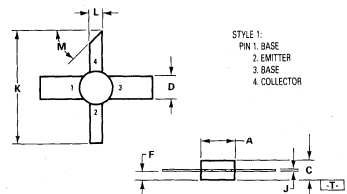
CLASS A BIAS NETWORK



AMPLIFIER



NOTE: The Printed Circuit Board shown is 75% of the original.



MRF1002MA, MRF1002MB, MRF1002MC

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 35\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
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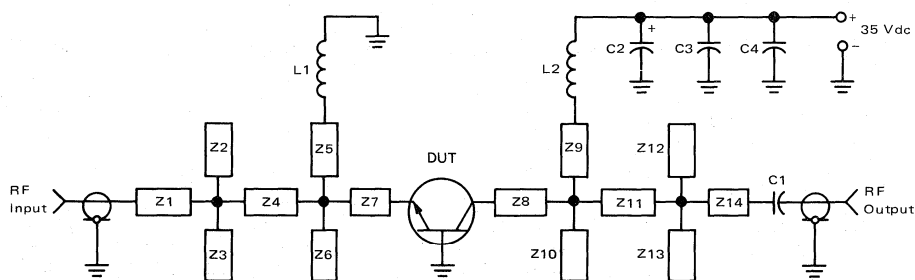
DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 35\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	2.5	5.0	pF
---	----------	---	-----	-----	----

FUNCTIONAL TESTS (Pulse Width = $10\text{ }\mu\text{s}$, Duty Cycle = 1.0%)

Common-Base Amplifier Power Gain ($V_{CC} = 35\text{ Vdc}$, $P_{out} = 2.0\text{ W pk}$, $f = 1090\text{ MHz}$)	G_{PB}	10	12	—	dB
Collector Efficiency ($V_{CC} = 35\text{ Vdc}$, $P_{out} = 2.0\text{ W pk}$, $f = 1090\text{ MHz}$)	η	40	45	—	%
Load Mismatch ($V_{CC} = 35\text{ Vdc}$, $P_{out} = 2.0\text{ W}$, $f = 1090\text{ MHz}$ $V_{SWR} = 10:1$ All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C3 — 220 pF Chip Capacitor, 100 mil ATC
 C2 — 20 $\mu\text{F}/50\text{ Vdc}$ Electrolytic
 C4 — 0.1 μF Erie Redcap
 L1, L2 — 2 Turns #18 AWG, 1/8" ID
 Z1-Z14 — Distributed Microstrip Elements — See Figure 9
 Board Material — 0.031" Thick Teflon-Fiberglass,
 $\epsilon_r = 2.56$

FIGURE 2 – OUTPUT POWER versus INPUT POWER

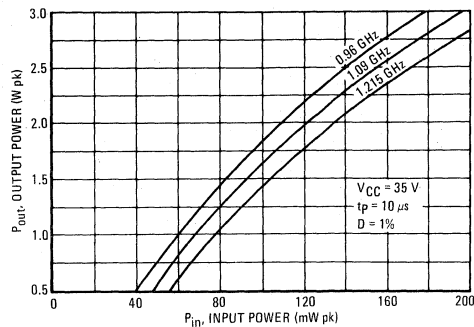


FIGURE 3 – OUTPUT POWER versus FREQUENCY

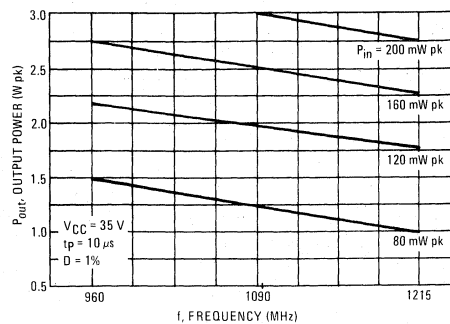


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

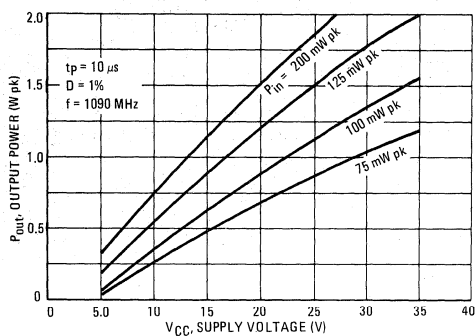


FIGURE 5 – POWER GAIN versus FREQUENCY

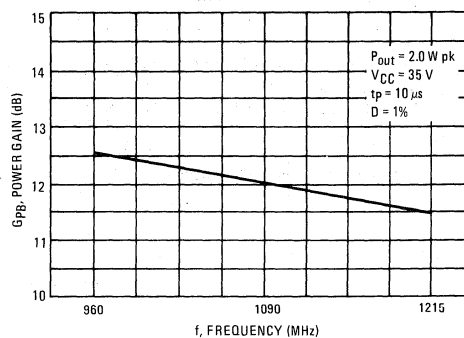
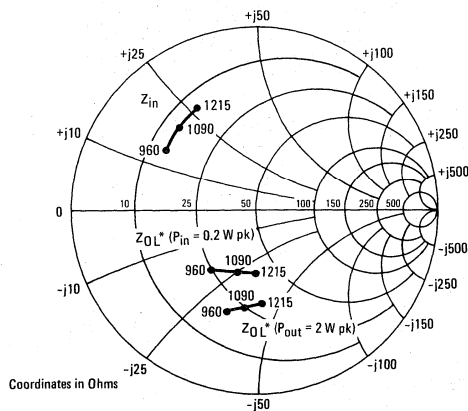


FIGURE 6 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

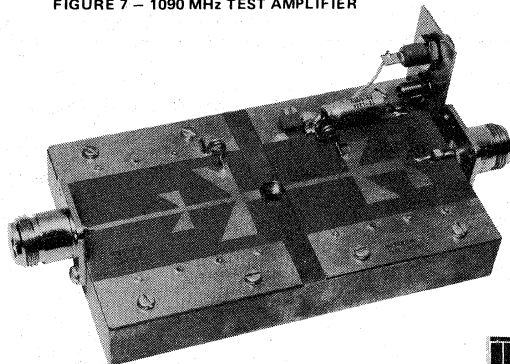


$V_{CC} = 35$ Vdc,
 $t_p = 10$ μ s, $D = 1.0\%$

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms $P_{out} = 2$ W pk	Z_{OL}^* Ohms $P_{in} = 0.2$ W pk
960	$15.5 + j16.5$	$20 + j32.5$	$25 + j21$
1090	$15 + j20$	$25 + j34$	$31 + j26$
1215	$14 + j27$	$33.5 + j42.5$	$37 + j32.5$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 – 1090 MHz TEST AMPLIFIER



$P_{out} = 2.0 \text{ W pk}$
 $V_{CC} = 35 \text{ V}$
 $t_p = 1.0 \text{ ms}$
 $D = 10\%$
 $f = 1090 \text{ MHz}$

FIGURE 8 – TYPICAL LONG PULSE PERFORMANCE

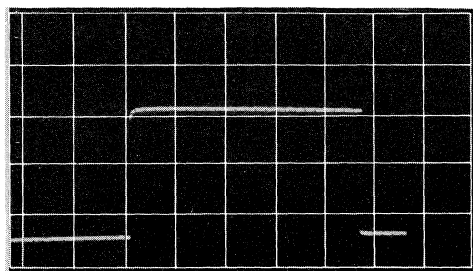
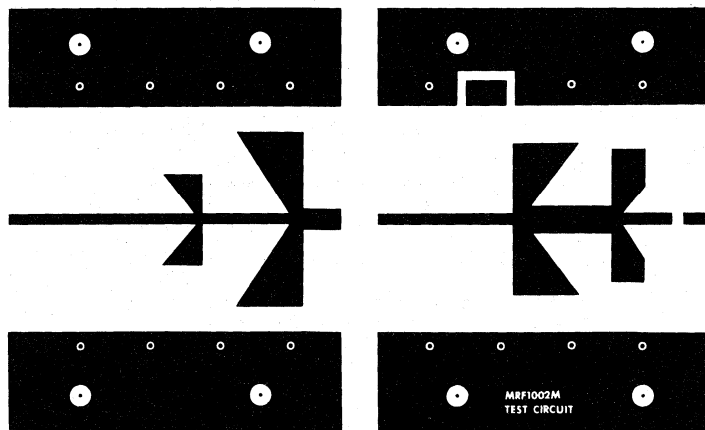


FIGURE 9 – PRINTED CIRCUIT BOARD LAYOUT – 1090 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

... designed for Class B and C *common base* amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 35 Vdc
Output Power = 4.0 Watts Peak
Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1004M Types
- Internal Input Matching for Broadband Operation

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	250	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	7.0 40	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

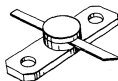
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	$^\circ\text{C}/\text{W}$

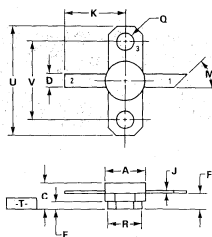
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF1004MC CASE 361A-01



STYLE 1:
PIN 1: COLLECTOR
2: EMITTER
3: BASE



NOTES:
1. DIMENSIONS R AND U ARE DATUMS AND T IS A DATUM SURFACE AND SEATING PLANE.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
[+/- 0.38 (0.015) (0) T T U (0) R (0)]
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
C	4.44	5.20	0.175	0.205
D	2.36	2.21	0.093	0.107
E	1.39	1.77	0.055	0.070
F	2.66	3.42	0.105	0.135
J	0.10	0.15	0.004	0.006
K	11.04	—	0.435	—
M	45° NOM	—	45° NOM	—
Q	3.04	34.2	0.120	0.135
R	0.09	0.66	0.240	0.260
U	20.06	20.52	0.790	0.810
V	14.27 BSC	—	0.562 BSC	—

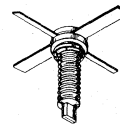
MRF1004MA MRF1004MB MRF1004MC

4.0 W 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

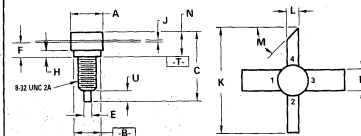
MRF1004MA CASE 332-04



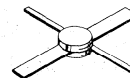
STYLE 1:
PIN 1: BASE
2: EMITTER
3: BASE
4: COLLECTOR

NOTES:
1. DIM [A] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
[+/- 0.76 (0.030) (0) T T B (0)]
3. [T] IS SEATING PLANE.
4. DIMENSION K APPLIES TWO PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.76	16.76	0.660	0.660
D	4.95	5.21	0.195	0.206
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM	—	45° NOM	—
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

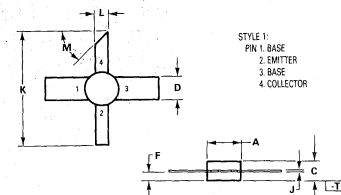


MRF1004MB CASE 332A-01



NOTES:
1. DIM [A] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
[+/- 0.76 (0.030) (0) T T A (0)]
3. [T] IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	6.85	7.34	0.270	0.290
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.206
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM	—	45° NOM	—



STYLE 1:
PIN 1: BASE
2: EMITTER
3: BASE
4: COLLECTOR

MRF1004MA, MRF1004MB, MRF1004MC

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 5.0 mA, I _B = 0)	V _{(BR)CEO}	20	—	—	V _{dc}
Collector-Emitter Breakdown Voltage (I _C = 5.0 mA, V _{BE} = 0)	V _{(BR)CES}	50	—	—	V _{dc}
Collector-Base Breakdown Voltage (I _C = 5.0 mA, I _E = 0)	V _{(BR)CBO}	50	—	—	V _{dc}
Emitter-Base Breakdown Voltage (I _E = 1.0 mA, I _C = 0)	V _{(BR)EBO}	3.5	—	—	V _{dc}
Collector Cutoff Current (V _{CB} = 35 V _{dc} , I _E = 0)	I _{CBO}	—	—	0.5	mA _{dc}

ON CHARACTERISTICS

DC Current Gain (I _C = 75 mA, V _{CE} = 5.0 V _{dc})	h _{FE}	10	—	100	—
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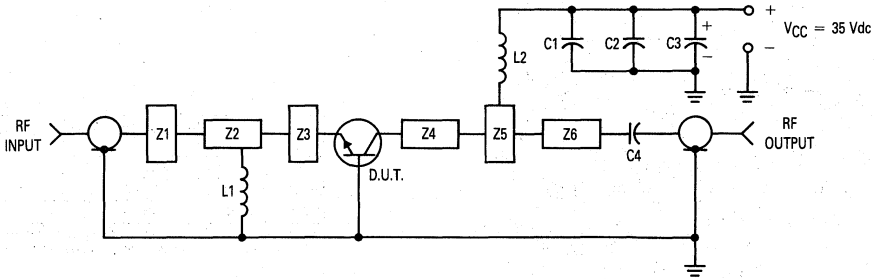
DYNAMIC CHARACTERISTICS

Output Capacitance (V _{CB} = 35 V _{dc} , I _E = 0, f = 1.0 MHz)	C _{ob}	—	3.3	5.0	pF
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FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)

Common-Base Amplifier Power Gain (V _{CC} = 35 V _{dc} , P _{out} = 4.0 W pk, f = 1090 MHz)	G _{PB}	10	11	—	dB
Collector Efficiency (V _{CC} = 35 V _{dc} , P _{out} = 4.0 W pk, f = 1090 MHz)	η	40	45	—	%
Load Mismatch (V _{CC} = 35 V _{dc} , P _{out} = 4.0 W pk, f = 1090 MHz VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1. 1090 MHz TEST CIRCUIT



L1, L2 — 3 Turns #18 AWG, 1/8" ID
C1 — 0.1 μF
C2, C4 — 220 pF Chip Capacitor
C3 — 20 μF, 50 V Electrolytic
Board Material — 0.031" Thick Glass Teflon
Z1–Z6 Distributed Microstrip Elements — See Figure 9

FIGURE 2 — OUTPUT POWER versus INPUT POWER

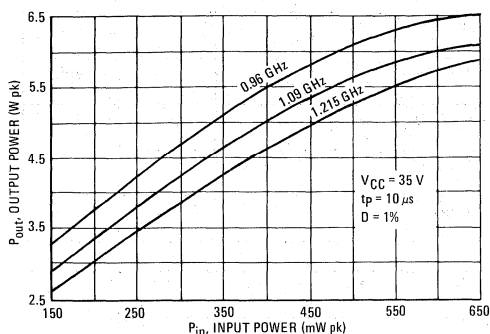


FIGURE 3 — OUTPUT POWER versus FREQUENCY

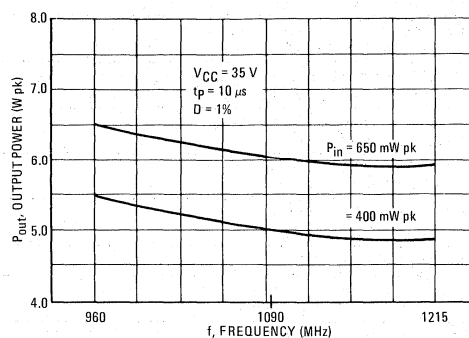


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

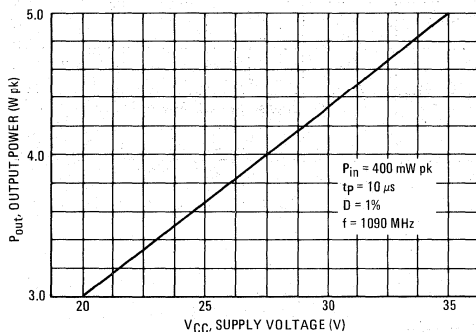


FIGURE 5 — POWER GAIN versus FREQUENCY

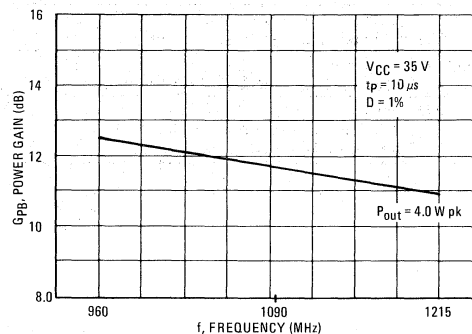
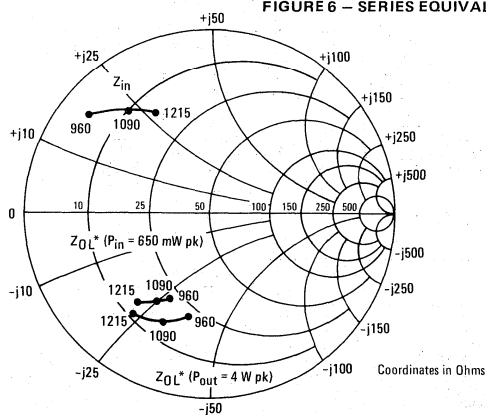


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

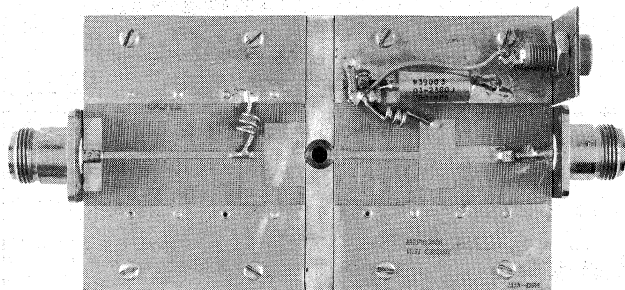


f MHz	Z _{in} Ohms	Z _{OL} * (P _{in} = 400 mW pk) Ohms	Z _{OL} * (P _{out} = 4 W pk) Ohms
960	5.0 + j17.5	23.5 - j26	22.5 - j36
1090	10 + j23	18.5 - j25	15 - j32.5
1215	16 + j29.5	15.5 - j23.5	11 - j23

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MRF1004MA, MRF1004MB, MRF1004MC

FIGURE 7 – 1090 MHz TEST AMPLIFIER



2

FIGURE 8 – TYPICAL LONG PULSE PERFORMANCE

$P_{out} = 4.0 \text{ W pk}$
 $V_{CC} = 35 \text{ V}$
 $t_p = 1.0 \text{ ms}$
 $D = 10\%$
 $f = 1090 \text{ MHz}$

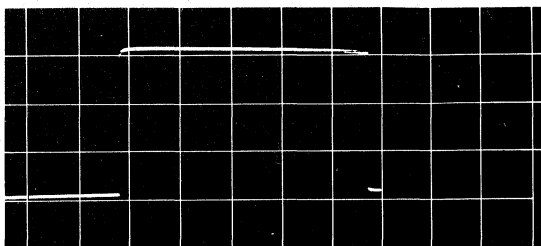
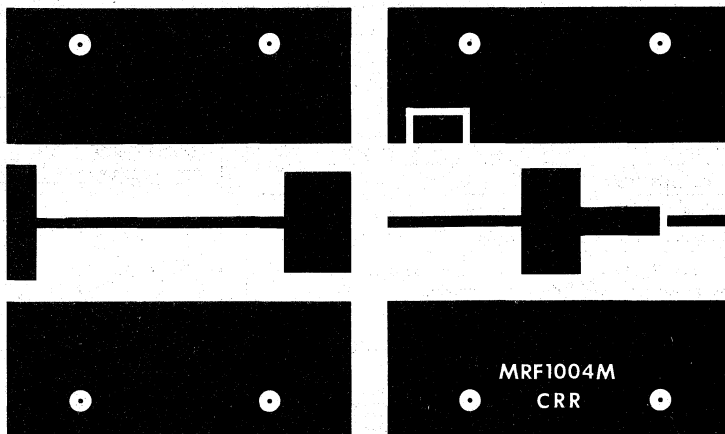


FIGURE 9 – PRINTED CIRCUIT BOARD LAYOUT – 1090 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

... designed for Class B and C *common-base* amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz; 35 Vdc
Output Power = 8.0 Watts Peak
Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1008M Types
- Internal Input Matching for Broadband Operation

MAXIMUM RATINGS

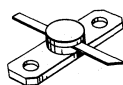
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	11.6 67	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

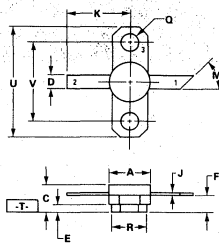
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	15	$^\circ\text{C}/\text{W}$

- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF1008MC CASE 361A-01



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE



- NOTES:
1. DIMENSIONS R AND U ARE DATUMS AND T IS A DATUM SURFACE AND SEATING PLANE.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
 $\pm 0.38 (0.015) \text{ T T U U R R}$
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	7.05	7.25	0.278	0.286
C	4.44	5.20	0.175	0.205
D	2.36	2.71	0.093	0.107
E	1.39	1.77	0.055	0.070
F	2.65	3.42	0.105	0.135
J	0.10	0.15	0.004	0.006
K	11.04	—	0.435	—
M	45° NOM	45° NOM	—	—
Q	3.04	34.2	0.120	0.135
R	6.09	6.66	0.240	0.260
U	20.06	20.57	0.790	0.810
V	14.27 BSC	—	0.562 BSC	—

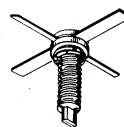
MRF1008MA MRF1008MB MRF1008MC

8.0 W PEAK 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

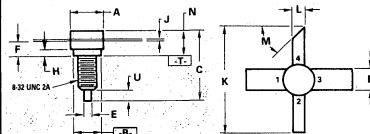
MRF1008MA CASE 332-04



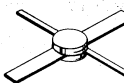
STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

- NOTES:
1. DIM [] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
 $\pm 0.76 (0.030) \text{ T T B B}$
3. [] IS SEATING PLANE.
4. DIMENSION K APPLIES TWO PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.25	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.87	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM	45° NOM	—	—
N	4.57	6.32	0.180	0.245
U	2.92	3.68	0.115	0.145

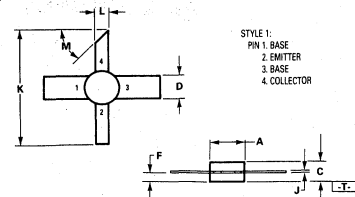


MRF1008MB CASE 332A-01



- NOTES:
1. DIM [] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
 $\pm 0.76 (0.030) \text{ T T A A}$
3. [] IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	6.85	7.34	0.270	0.290
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM	45° NOM	—	—



MRF1008MA, MRF1008MB, MRF1008MC

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 35\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 150\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
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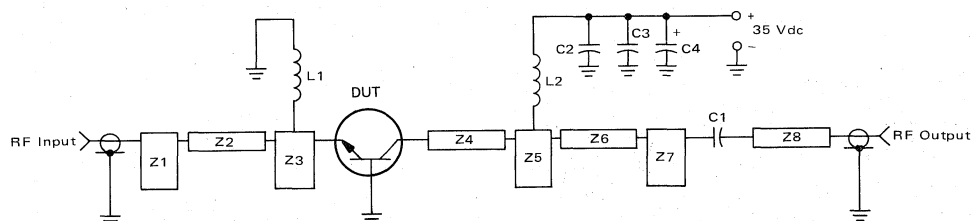
DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 35\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	3.5	6.0	pF
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FUNCTIONAL TESTS (Pulse Width = $10\text{ }\mu\text{s}$, Duty Cycle = 1%)

Common-Base Amplifier Power Gain ($V_{CC} = 35\text{ Vdc}$, $P_{out} = 8.0\text{ W Peak}$, $f = 1090\text{ MHz}$)	G_{PB}	10	12	—	dB
Collector Efficiency ($V_{CC} = 35\text{ Vdc}$, $P_{out} = 8.0\text{ W Peak}$, $f = 1090\text{ MHz}$)	η	40	45	—	%
Load Mismatch ($V_{CC} = 35\text{ Vdc}$, $P_{out} = 8.0\text{ W Peak}$, $f = 1090\text{ MHz}$, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 220 pF 100 mil Chip Capacitor
C3 — $0.1\text{ }\mu\text{F}$
C4 — $10\text{ }\mu\text{F}/50\text{ V}$ Electrolytic Capacitor

L1, L2 — 3 Turns #18 AWG, $1/8\text{"}\text{ ID}$
Z1 — Z8 — Microstrip, See Photomaster
Board Material — $0.031\text{"}\text{ Glass Teflon}$, $\epsilon_r = 2.5$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

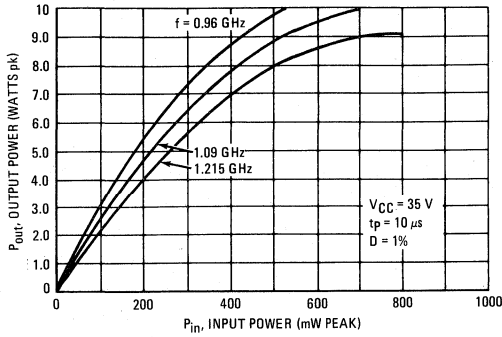


FIGURE 3 — OUTPUT POWER versus FREQUENCY

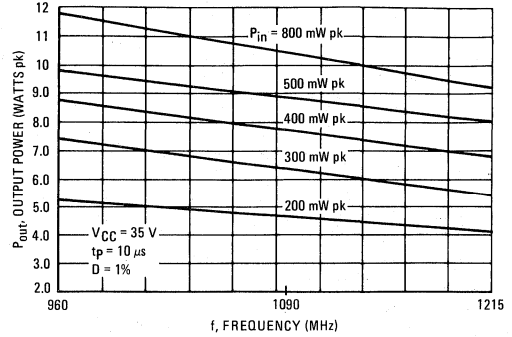


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

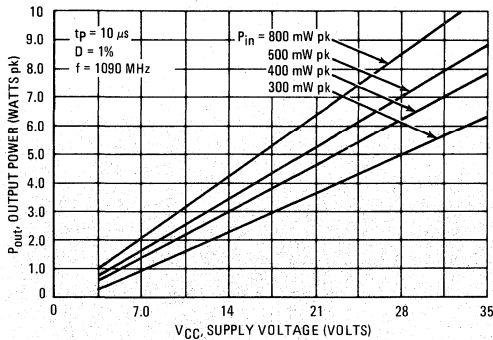


FIGURE 5 — POWER GAIN versus FREQUENCY

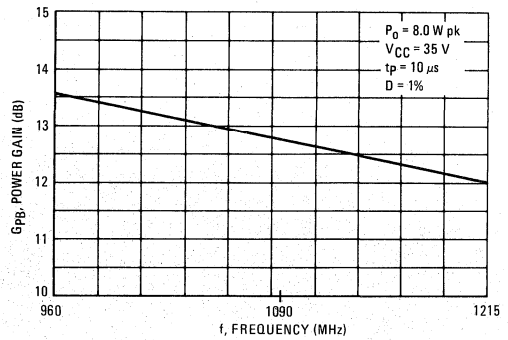
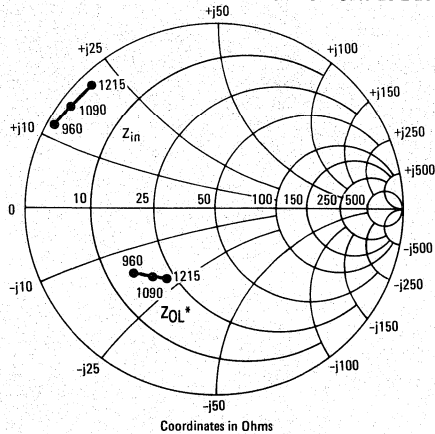


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



$V_{CC} = 35 \text{ V}$
 $P_o = 8.0 \text{ W pk}$

f MHz	Z_{in} Ohms	$*Z_{oL}$ Ohms
960	$1.5 + j13$	$17 - j16$
1090	$2.0 + j17$	$20 - j18.5$
1215	$3.0 + j20$	$23 - j20$

* Z_{oL} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

MRF1008MA, MRF1008MB, MRF1008MC

FIGURE 7—1090 MHz TEST AMPLIFIER

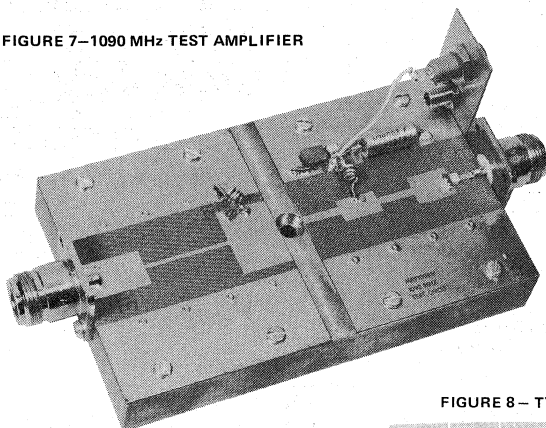


FIGURE 8—TYPICAL LONG PULSE PERFORMANCE

$P_{out} = 8.0 \text{ W peak}$
 $V_{CC} = 35 \text{ V}$
 $t_p = 1 \text{ ms}$
 $D = 10\%$
 $f = 1090 \text{ MHz}$

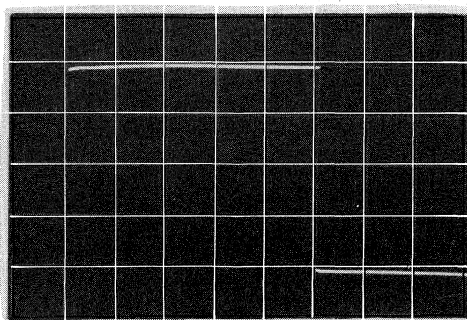
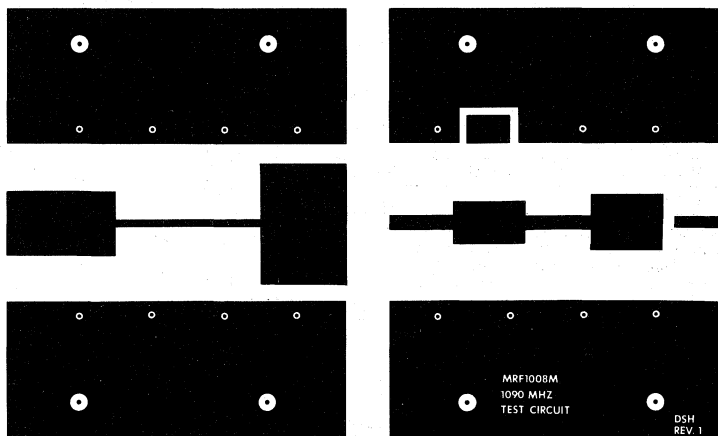


FIGURE 9—PRINTED CIRCUIT BOARD LAYOUT—1090 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

• Soldered Eyelet

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

... designed for Class B and C *common base* amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
Output power = 15 Watts Peak
Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1015M Types
- Internal Input Matching for Broadband Operation

MAXIMUM RATINGS

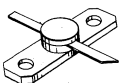
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CES}	60	Vdc
Collector-Base Voltage	V _{CBO}	60	Vdc
Emitter-Base Voltage	V _{EBO}	4.0	Vdc
Collector-Current — Continuous	I _C	1.0	Adc
Total Device Dissipation @ T _C = 25°C (1) Derate above 25°C	P _D	17.5 100	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

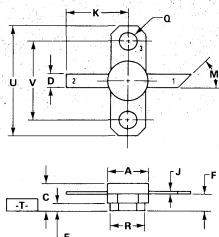
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	R _{θJC}	10	°C/W

- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF1015MC CASE 361A-01



STYLE 1:
PIN 1: COLLECTOR
2: EMITTER
3: BASE



- NOTES:
1. DIMENSIONS R AND U ARE DATUMS AND T IS A DATUM SURFACE AND SEATING PLANE.
 2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
Ⓢ Ⓡ 0.38 (0.015) Ⓢ Ⓡ T Ⓡ U Ⓢ Ⓡ R Ⓢ Ⓡ
 3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	7.08	7.26	0.278	0.286
C	4.44	5.20	0.175	0.205
D	2.36	2.71	0.093	0.107
E	1.38	1.71	0.055	0.070
F	2.66	3.42	0.105	0.135
J	0.10	0.15	0.004	0.006
K	11.04	—	0.435	—
M	45° NCM	—	45° NCM	—
Q	3.04	34.2	0.120	0.135
R	6.09	6.66	0.240	0.260
U	20.08	20.57	0.790	0.810
V	14.27	85C	0.562	85C

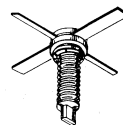
MRF1015MA MRF1015MB MRF1015MC

15 W PEAK 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

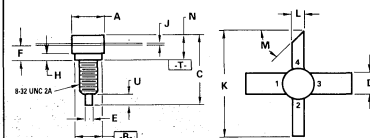
MRF1015MA CASE 332-04



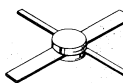
STYLE 1:
PIN 1: BASE
2: EMITTER
3: BASE
4: COLLECTOR

- NOTES:
1. DIM [B] IS DATUM.
 2. POSITIONAL TOLERANCE FOR LEADS:
Ⓢ Ⓡ 0.76 (0.030) Ⓢ Ⓡ T Ⓡ B Ⓢ Ⓡ
 3. [T] IS SEATING PLANE.
 4. DIMENSION K APPLIES TWO PLACES.
 5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	6.85	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NCM	—	45° NCM	—
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

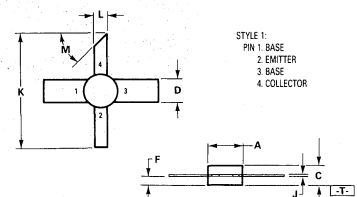


MRF1015MB CASE 332A-01



- NOTES:
1. DIM [A] IS DATUM.
 2. POSITIONAL TOLERANCE FOR LEADS:
Ⓢ Ⓡ 0.76 (0.030) Ⓢ Ⓡ T Ⓡ A Ⓢ Ⓡ
 3. [T] IS SEATING PLANE.
 4. DIM K APPLIES 2 PLACES.
 5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

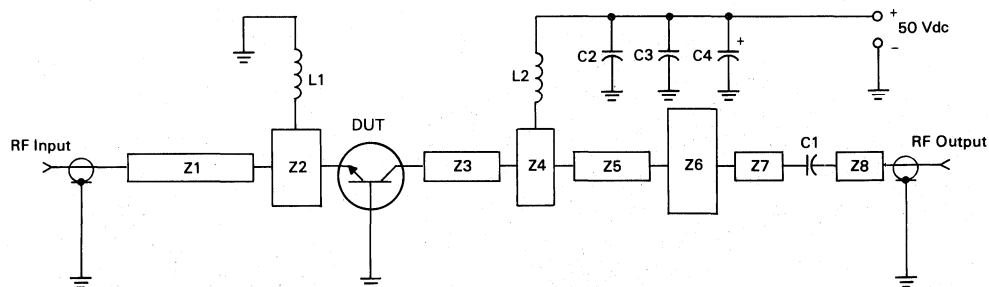
DIM	MIN	MAX	MIN	MAX
A	6.85	7.34	0.270	0.290
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.70	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NCM	—	45° NCM	—



STYLE 1:
PIN 1: BASE
2: EMITTER
3: BASE
4: COLLECTOR

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA _{dc}
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	40	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	5.0	7.5	pF
FUNCTIONAL TESTS (Pulse Width = $10\text{ }\mu\text{s}$, Duty Cycle = 1%)					
Common-Base Amplifier Power Gain ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 15\text{ W Peak}$, $f = 1090\text{ MHz}$)	G_{PB}	10	12.5	—	dB
Collector Efficiency ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 15\text{ W Peak}$, $f = 1090\text{ MHz}$)	η	30	35	—	%
Load Mismatch ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 15\text{ W Peak}$, $f = 1090\text{ MHz}$) ($V_{SWR} = 10:1$ All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 1090 MHz TEST CIRCUIT

C1, C2 — 220 pF 100 mil Chip Capacitor
 C3 — $0.1\text{ }\mu\text{F}$
 C4 — $47\text{ }\mu\text{F}/75\text{ V}$ Electrolytic Capacitor
 L1, L2 — 3 Turns #18 AWG, $1/8''$ ID
 Z1–Z8 — Microstrip, See Photomaster, Figure 8
 Board Material — $0.032''$ Glass Teflon
 $\epsilon_r = 2.5$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

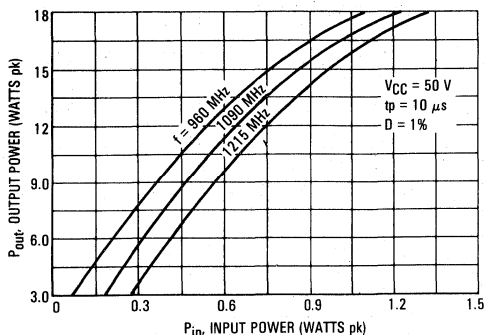


FIGURE 3 — OUTPUT POWER versus FREQUENCY

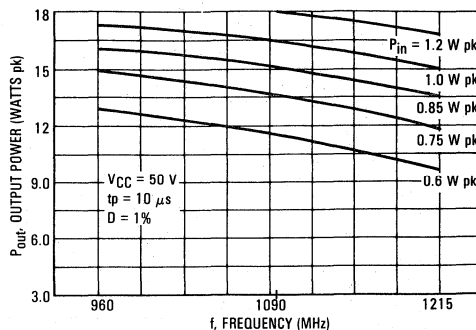


FIGURE 4 - OUTPUT POWER versus SUPPLY VOLTAGE

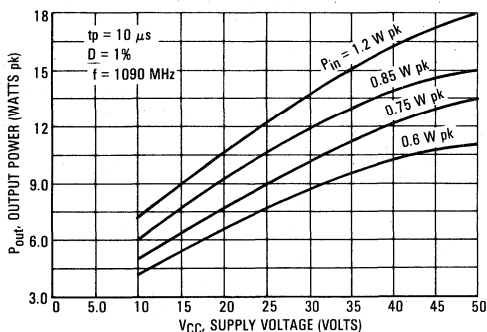


FIGURE 5 — POWER GAIN versus FREQUENCY

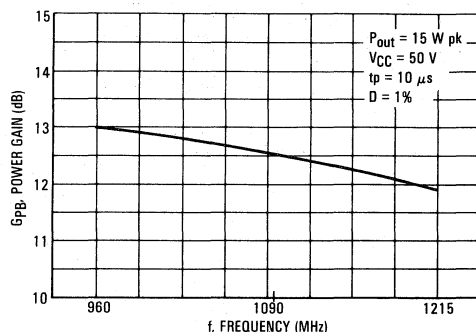
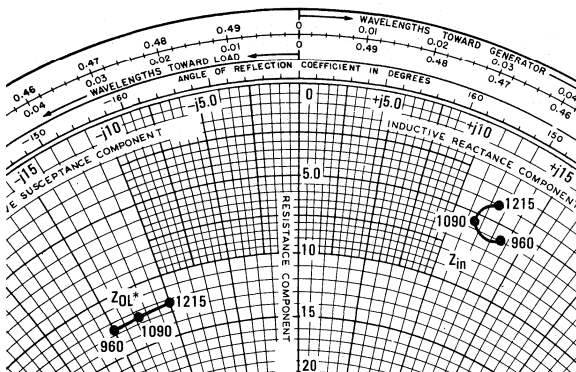


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



Coordinates in Ohms

$P_{out} = 15 \text{ W pk}$ $V_{CC} = 50 \text{ V}$
 $t_p = 10 \mu s$ $D = 1\%$

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
960	$5.9 + j13.6$	$12.5 - j15$
1090	$5.5 + j11.5$	$12.4 - j12.8$
1215	$4.0 + j12.5$	$12.1 - j10$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER

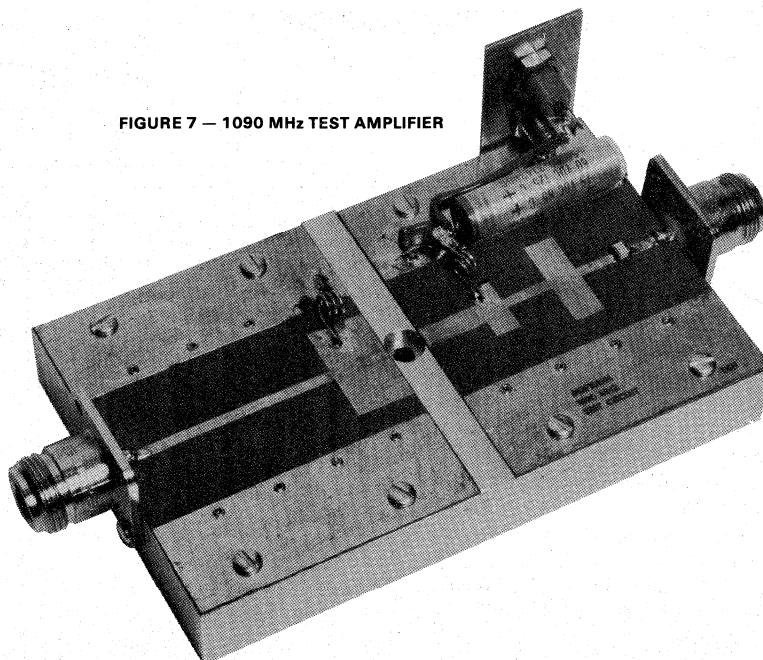
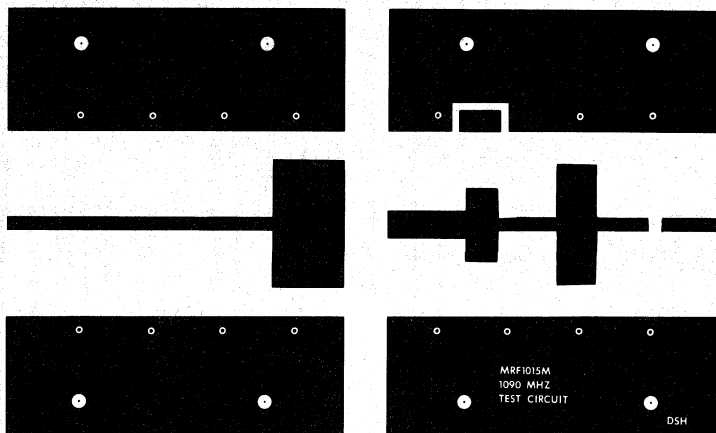


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



- Soldered Eyelet
- 4-40 Screw Placement

NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

... designed for Class B and C *common-base* amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
Output Power = 35 Watts Peak
Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1035M Types
- Internal Input Matching for Broadband Operation

MAXIMUM RATINGS

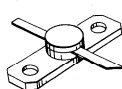
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CES}	60	Vdc
Collector-Base Voltage	V _{CBO}	60	Vdc
Emitter-Base Voltage	V _{EBO}	4.0	Vdc
Collector-Current — Continuous	I _C	2.0	Adc
Total Device Dissipation @ T _C = 25°C(1) Derate above 25°C	P _D	35 200	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

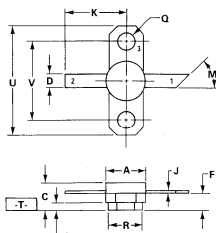
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	R _{θJC}	5.0	°C/W

- These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF1035MC CASE 361A-01



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE



- NOTES:
1. DIMENSIONS R AND U ARE DATUMS AND T IS A DATUM SURFACE AND SEATING PLANE.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
[+/- 0.38 (0.015) (0.1) T] [A] [R] [U]
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	7.95	7.96	0.278	0.296
C	4.44	5.29	0.175	0.209
D	2.35	2.71	0.093	0.107
E	1.39	1.77	0.055	0.070
F	2.66	3.42	0.105	0.135
J	0.10	0.15	0.004	0.006
K	11.05	—	0.435	—
M	45° NOM	—	45° NOM	—
Q	3.04	34.2	0.120	0.135
R	0.09	0.66	0.240	0.260
U	20.05	20.57	0.790	0.810
V	14.27 BSC	—	0.562 BSC	—

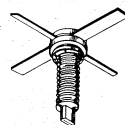
MRF1035MA MRF1035MB MRF1035MC

35 W PEAK — 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

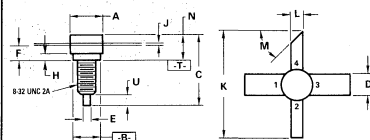
MRF1035MA CASE 332-04



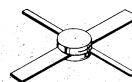
STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

- NOTES:
1. DIM [B] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
[+/- 0.75 (0.030) (0.1) T] [B] [D]
3. [T] IS SEATING PLANE.
4. DIMENSION K APPLIES TWO PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	5.85	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.25	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM	—	45° NOM	—
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

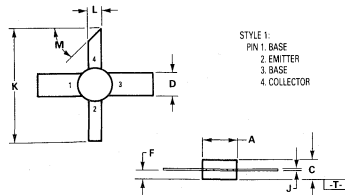


MRF1035MB CASE 332A-01



- NOTES:
1. DIM [A] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
[+/- 0.75 (0.030) (0.1) T] [A] [D]
3. [T] IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	0.65	7.24	0.020	0.290
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
E	1.40	1.78	0.055	0.070
F	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM	—	45° NOM	—

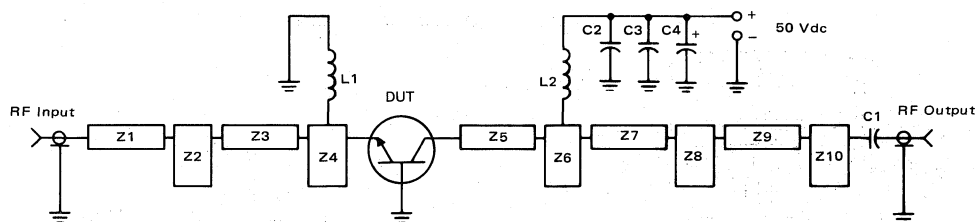


STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	2.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	40	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	10	15	pF
FUNCTIONAL TESTS (Pulse Width = $10\text{ }\mu\text{s}$, Duty Cycle = 1%)					
Common-Base Amplifier Power Gain ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 35\text{ W Peak}$, $f = 1090\text{ MHz}$)	G_{PB}	10	12.4	—	dB
Collector Efficiency ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 35\text{ W Peak}$, $f = 1090\text{ MHz}$)	η	30	34	—	%
Load Mismatch ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 35\text{ W Peak}$, $f = 1090\text{ MHz}$, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 220 pF 100 mil Chip Capacitor
 C3 — 0.1 μF
 C4 — 10 μF /75 V Electrolytic
 L1, L2 — 3 Turns #18 AWG, 1/8" ID

Z1—Z10 — Microstrip, See Photomaster
 Board Material — 0.031" Glass Teflon
 $\epsilon_R = 2.5$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

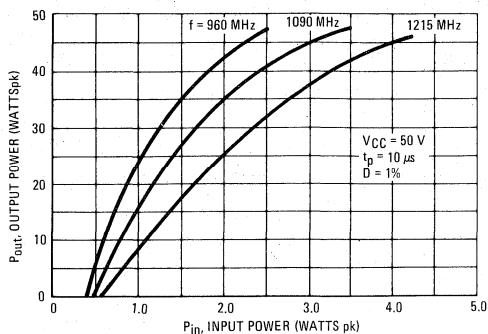


FIGURE 3 — OUTPUT POWER versus FREQUENCY

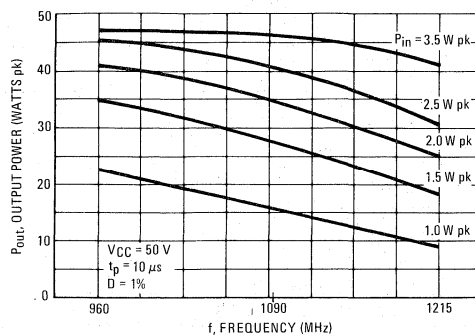


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

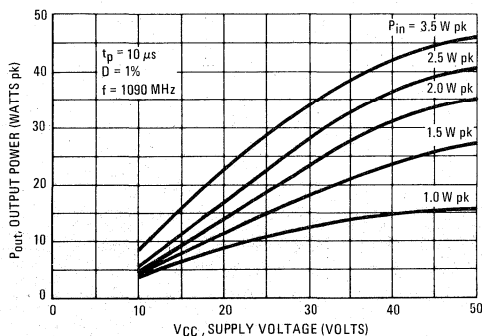


FIGURE 5 — POWER GAIN versus FREQUENCY

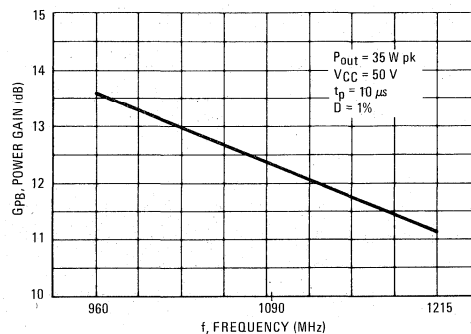
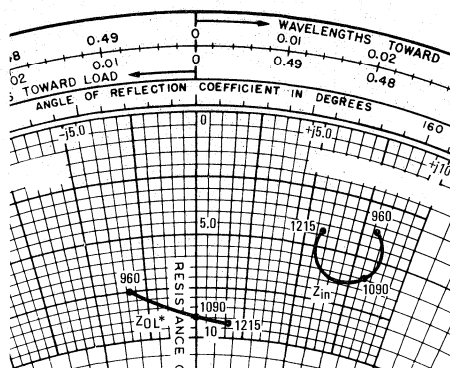


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

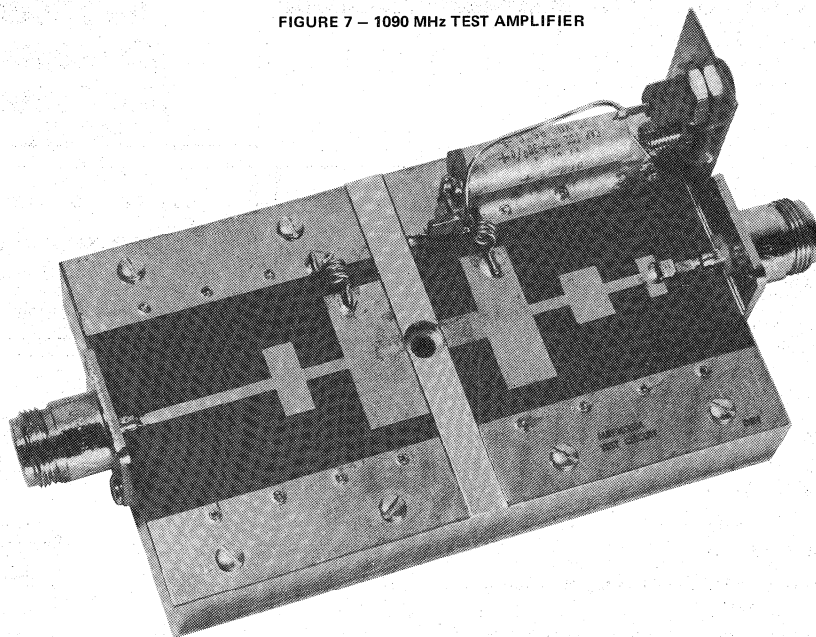


$P_{out} = 35\text{ W pk}$, $V_{CC} = 50\text{ V}$
 $t_p = 10\text{ }\mu\text{s}$, $D = 1\%$

f MHz	Z_{in} Ohms	Z_{out}^* Ohms
960	$3.8 + j8.2$	$7.5 - j3.3$
1090	$6.0 + j8.2$	$9.0 + j0$
1215	$4.2 + j5.7$	$9.1 + j1.7$

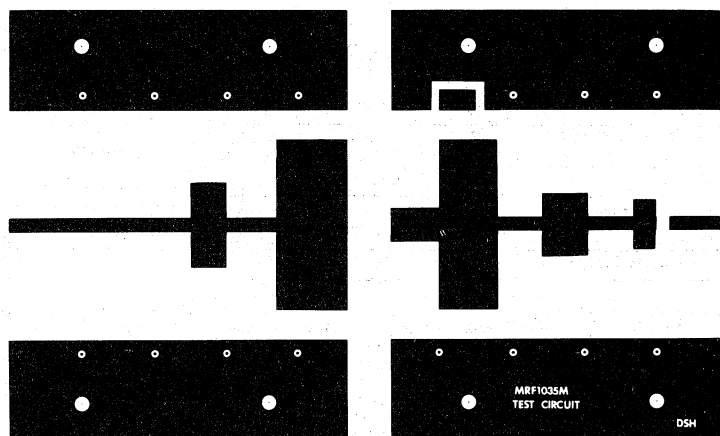
* Z_{out}^* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 – 1090 MHz TEST AMPLIFIER



2

FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 1090 MHz TEST CIRCUIT



⊙ Soldered Eyelets

NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

... designed for Class B and C *common base* amplifier applications in short pulse TACAN, IFF, and DME transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
Output power = 90 Watts Peak
Minimum Gain = 8.4 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized for Long Life and Resistance to Metal Migration
- Compatible with Other 1090M and 1075M Types
- Internal Input Matching for Broadband Operation

MAXIMUM RATINGS

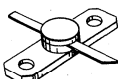
Rating	Symbol	Value	Unit
Collector-Base Voltage	V _{CBO}	70	Vdc
Emitter-Base Voltage	V _{EBO}	4.0	Vdc
Collector-Current — Peak (1)	I _C	6.0	Adc
Peak Device Dissipation @ T _C = 25°C (1) (2)	P _D	290	Watts
Derate above 25°C		1.66	W/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

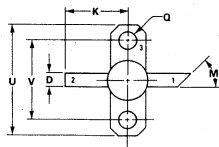
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	R _{θJC}	0.6	°C/W

- (1) Pulse Width = 10 μs, Duty Cycle = 1%.
- (2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF short pulse amplifiers.
- (3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF1090MC CASE 361A-01



STYLE 1:
PIN 1: COLLECTOR
2: EMITTER
3: BASE



- NOTES:
1. DIMENSIONS R AND U ARE DATUMS AND T IS A DATUM SURFACE AND SEATING PLANE.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
[+/-] 0.38 (0.015) [M] [T] [U] [R] [S]
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
C	4.44	5.20	0.175	0.205
D	2.36	2.71	0.093	0.107
E	1.39	1.77	0.055	0.070
F	2.66	3.42	0.105	0.135
G	0.10	0.15	0.004	0.006
K	11.04	—	0.435	—
M	45° NOM	—	45° NOM	—
Q	3.04	3.42	0.120	0.135
R	6.69	6.86	0.260	0.270
U	28.96	29.97	0.790	0.893
V	14.27 BSC	—	0.562 BSC	—

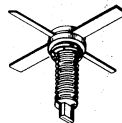
MRF1090MA MRF1090MB MRF1090MC

90 W PEAK, 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

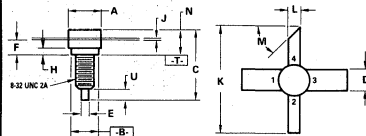
MRF1090MA CASE 332-04



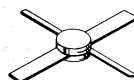
STYLE 1:
PIN 1: BASE
2: EMITTER
3: BASE
4: COLLECTOR

- NOTES:
1. DIM [E] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
[+/-] 0.76 (0.030) [M] [T] [U] [R] [S]
3. [T] IS SEATING PLANE.
4. DIMENSION K APPLIES TWO PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM	—	45° NOM	—
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

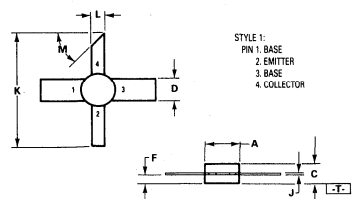


MRF1090MB CASE 332A-01



- NOTES:
1. DIM [A] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS:
[+/-] 0.76 (0.030) [M] [T] [U] [R] [S]
3. [T] IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	6.85	7.34	0.270	0.290
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM	—	45° NOM	—

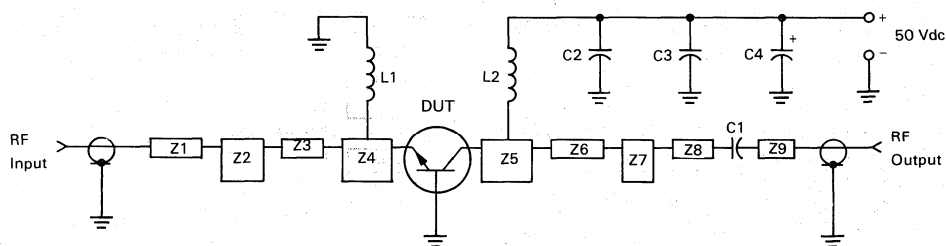


STYLE 1:
PIN 1: BASE
2: EMITTER
3: BASE
4: COLLECTOR

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	5.0	mA
ON CHARACTERISTICS					
DC Current Gain* ($I_C = 2.5\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	12	16	pF
FUNCTIONAL TESTS (Pulse Width = $10\text{ }\mu\text{s}$, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 90\text{ W pk}$, $f = 1090\text{ MHz}$)	G_{PB}	8.4	10.8	—	dB
Collector Efficiency ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 90\text{ W pk}$, $f = 1090\text{ MHz}$)	η	35	40	—	%
Load Mismatch ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 90\text{ W pk}$, $f = 1090\text{ MHz}$, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

* 80 μs Pulse on Tektronix 576 or equivalent.

FIGURE 1 — 1090 MHz TEST CIRCUIT

C1, C2 — 220 pF Chip Capacitor, 100-mil ATC
 C3 — 0.1 μF
 C4 — 47 μF , 75 V
 L1, L2 — 3 Turns, #18 AWG, 1/8" ID
 Z1-Z9 — Distributed Microstrip Elements — See Figure 9
 Board Material — 0.031" Thick Glass Teflon,
 $\epsilon_r = 2.5$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

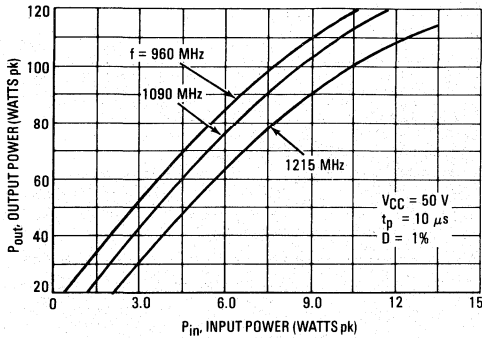


FIGURE 3 — OUTPUT POWER versus FREQUENCY

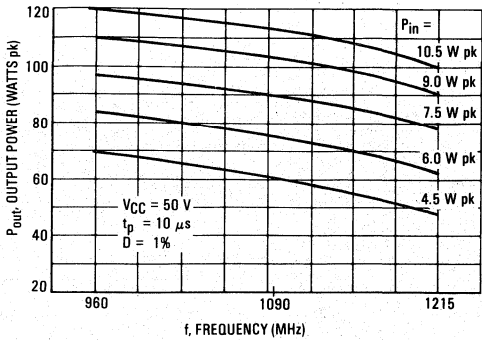


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

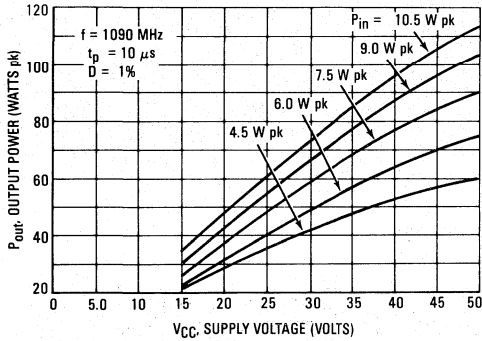


FIGURE 5 — POWER GAIN versus FREQUENCY

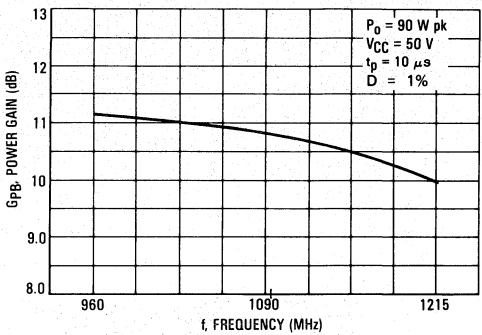
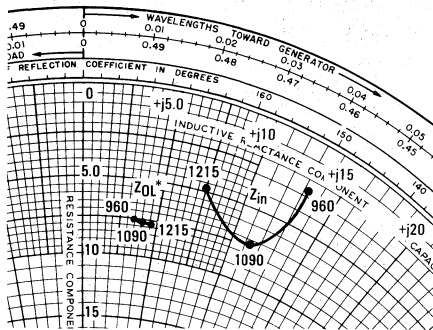


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

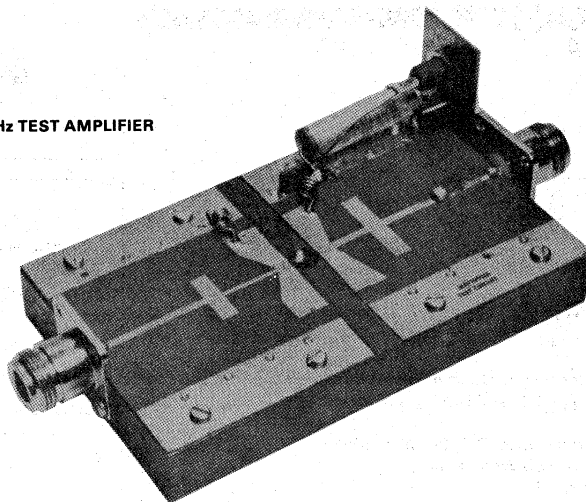


$P_{out} = 90 \text{ W pk}$ $V_{cc} = 50 \text{ V}$
 $t_p = 10 \mu s$ $D = 1\%$

f MHz	Z_{in} Ohms	Z_{out}^* Ohms
960	$2.8 + j13.2$	$7.6 + j3.5$
1090	$7.4 + j11.4$	$7.6 + j4.0$
1215	$4.7 + j7.5$	$7.7 + j4.5$

* Z_{out} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER



2

FIGURE 8 — TYPICAL PULSE PERFORMANCE

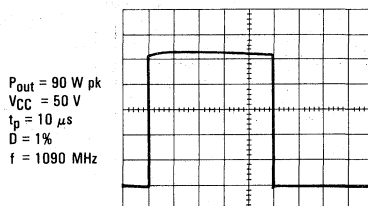
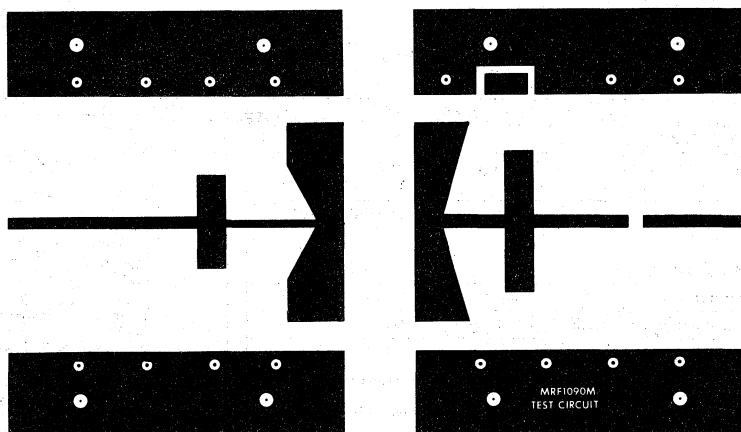


FIGURE 9 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



- Soldered Eyelet
- 4-40 Screw Placement

NOTE: The Printed Circuit Board shown is 75% of the original.

MRF1150M

The RF Line

MICROWAVE PULSE POWER TRANSISTOR

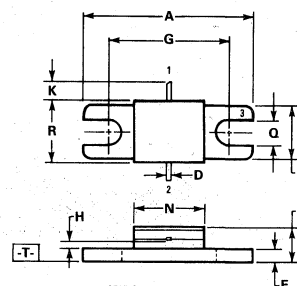
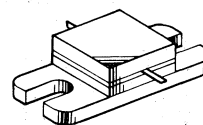
... designed for Class B and C *common base* amplifier applications in short pulse TACAN, IFF, and DME transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
Output Power = 150 Watts Peak
Minimum Gain = 7.8 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized for Long Life and Resistance to Metal Migration
- Compatible with Other 1150M Types
- Internal Input and Output Matching for Broadband Operation

150 W PEAK, 1020-1150 MHz

MICROWAVE POWER TRANSISTOR

NPN SILICON



STYLE 2:
 PIN 1. COLLECTOR
 2. EMITTER
 3. BASE

- NOTES:
1. DIMENSIONS A, B AND R ARE DATUMS.
 2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
 $\pm 0.76 (0.030) \text{ (M) T A (M) B (M)}$
 3. POSITIONAL TOLERANCE FOR LEADS:
 $\pm 0.25 (0.010) \text{ (M) T A (M) R (M)}$
 4. --T-- IS BOTH A SEATING PLANE AND A DATUM SURFACE.
 5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.61	23.11	0.890	0.910
B	9.65	9.91	0.380	0.390
C	4.06	5.84	0.160	0.230
D	0.51	0.76	0.020	0.030
E	1.40	1.65	0.055	0.065
G	16.51 BSC		0.650 BSC	
H	1.14	1.77	0.045	0.070
K	2.54	—	0.100	—
N	9.91	10.41	0.390	0.410
Q	3.00	3.61	0.118	0.142
R	9.91	10.41	0.390	0.410

CASE 336-03

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V _{CBO}	70	Vdc
Emitter-Base Voltage	V _{EBO}	4.0	Vdc
Collector-Current — Peak (1, 2)	I _C	12	Adc
Peak Device Dissipation @ T _C = 25°C (1, 2) Derate above 25°C	P _D	583 3.33	Watts W/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1,2,3)	R _{θJC}	0.3	°C/W

- (1) Pulse Width = 10 μs, Duty Cycle = 1%.
- (2) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF short pulse amplifier.
- (3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 50 mAdc, V _{BE} = 0)	V _{(BR)CES}	70	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 50 mAdc, I _E = 0)	V _{(BR)CBO}	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 5.0 mAdc, I _C = 0)	V _{(BR)EBO}	4.0	—	—	Vdc
Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0)	I _{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain* (I _C = 5.0 Adc, V _{CE} = 5.0 Vdc)	h _{FE}	10	30	—	—
FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V _{CC} = 50 Vdc, P _{out} = 150 W pk, f = 1090 MHz)	G _{PB}	7.8	8.7	—	dB
Collector Efficiency (V _{CC} = 50 Vdc, P _{out} = 150 W pk, f = 1090 MHz)	η	33	—	—	%
Load Mismatch (V _{CC} = 50 Vdc, P _{out} = 150 W pk, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

*80 μs Pulse on Tektronix 576 or equivalent.

FIGURE 1 — 1090 MHz TEST CIRCUIT

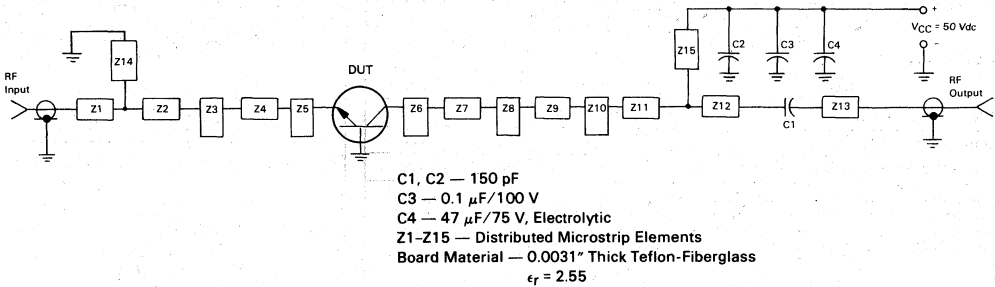


FIGURE 2 — OUTPUT POWER versus INPUT POWER

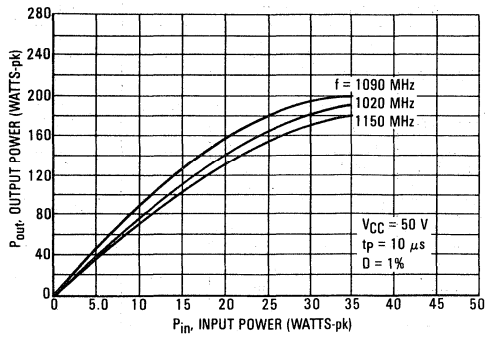


FIGURE 3 — OUTPUT POWER versus FREQUENCY

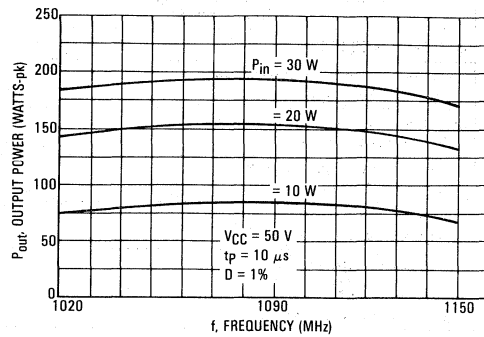


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

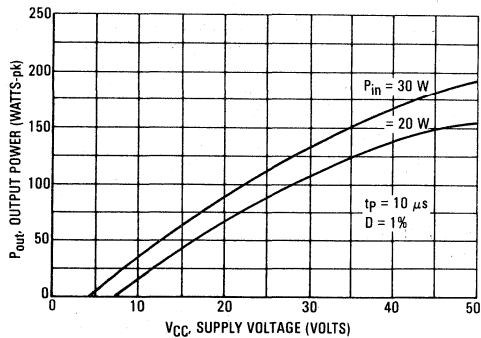


FIGURE 5 — POWER GAIN versus FREQUENCY

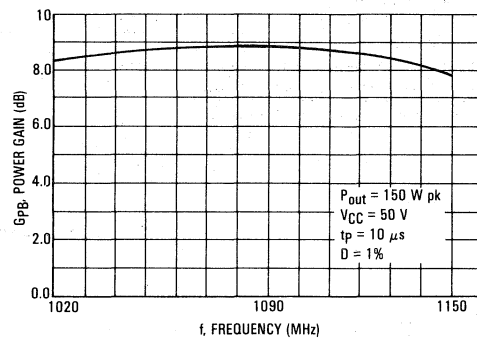
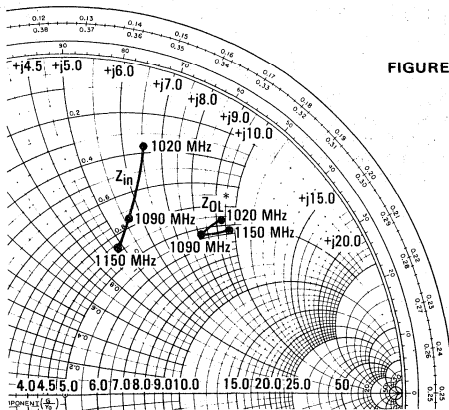


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



$P_{out} = 150 \text{ W-pk}$ $V_{cc} = 50 \text{ V}$
 $t_p = 10 \mu s$ $D = 1\%$

f MHz	Z_{in} Ohms	Z_{L}^* Ohms
1020	$1.85 + j6.6$	$4.6 + j9.4$
1090	$3.5 + j5.7$	$5.3 + j8.1$
1150	$4.4 + j4.8$	$5.2 + j9.7$

* Z_L = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

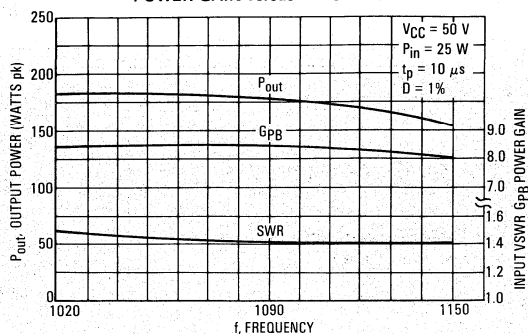
FIGURE 7 — OUTPUT POWER, INPUT VSWR,
POWER GAIN versus FREQUENCY

FIGURE 8 — 1090 MHz TEST CIRCUIT

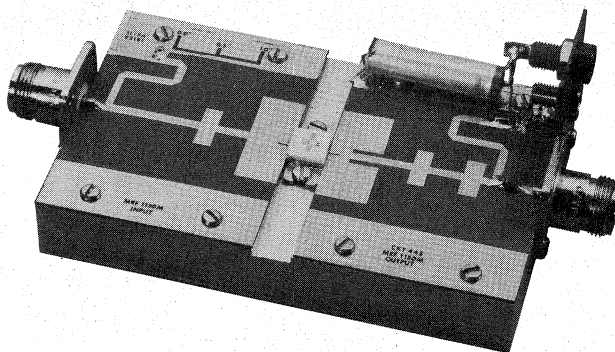
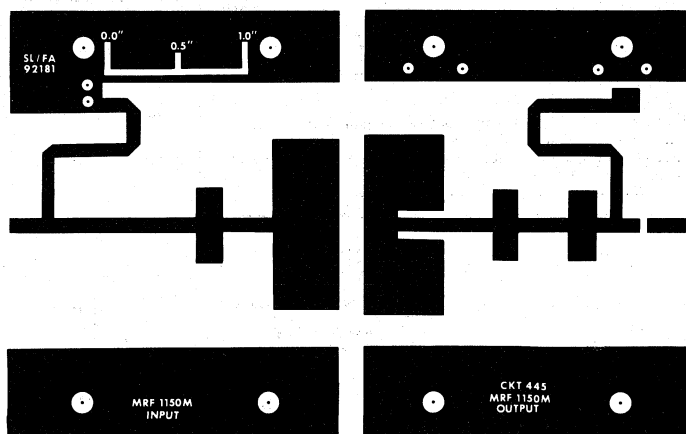
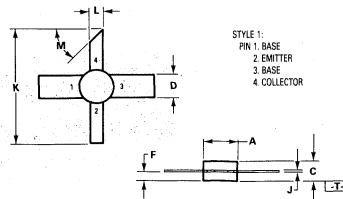


FIGURE 9 — 1090 MHz PHOTOMASTER

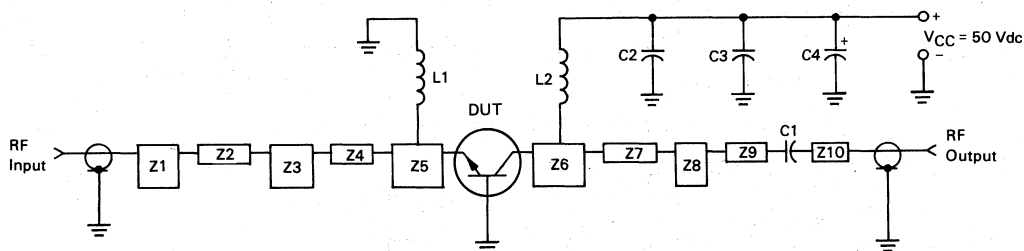


NOTE: The Printed Circuit Board shown is 75% of the original.



ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	mA
ON CHARACTERISTICS					
DC Current Gain* ($I_C = 5.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 50\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	25	32	pF
FUNCTIONAL TESTS (Pulse Width = $10\text{ }\mu\text{s}$, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 150\text{ W pk}$, $f = 1090\text{ MHz}$)	G_{PB}	7.8	9.8	—	dB
Collector Efficiency ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 150\text{ W pk}$, $f = 1090\text{ MHz}$)	η	35	40	—	%
Load Mismatch ($V_{CC} = 50\text{ Vdc}$, $P_{out} = 150\text{ W pk}$, $f = 1090\text{ MHz}$) VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

*80 μs Pulse on Tektronix 576 or equivalent.**FIGURE 1 — 1090 MHz TEST CIRCUIT**

C1, C2 — 220 pF Chip Capacitor, 100-mil ATC
 C3 — $0.1\text{ }\mu\text{F}/100\text{ V}$
 C4 — $47\text{ }\mu\text{F}/75\text{ V}$ Electrolytic
 L1, L2 — 3 Turns, #18 AWG, $1/8''$ ID
 Z1-Z10 — Distributed Microstrip Elements — See Figure 9
 Board Material — 0.031" Thick Teflon-Fiberglass,
 $\epsilon_r = 2.5$

FIGURE 2 — OUTPUT POWER versus INPUT POWER

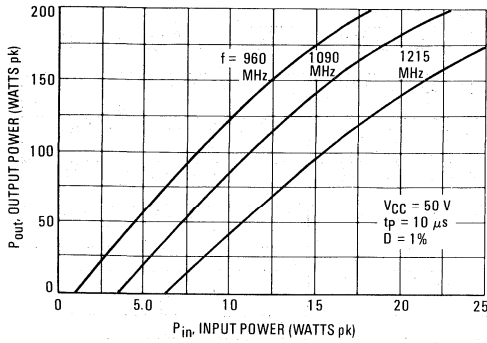


FIGURE 3 — OUTPUT POWER versus FREQUENCY

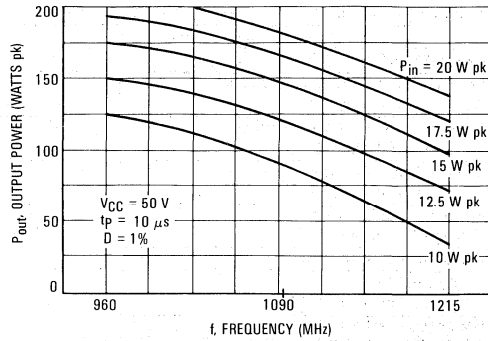


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

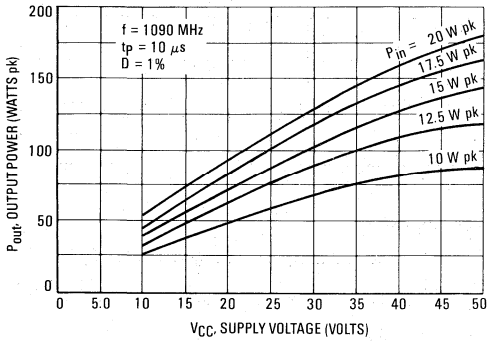


FIGURE 5 — POWER GAIN versus FREQUENCY

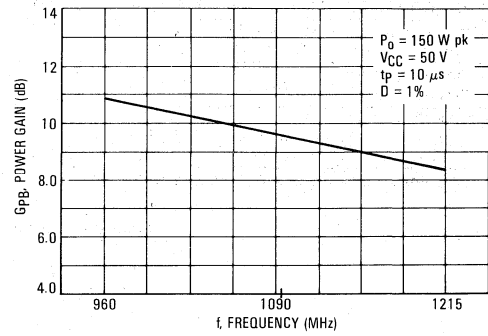
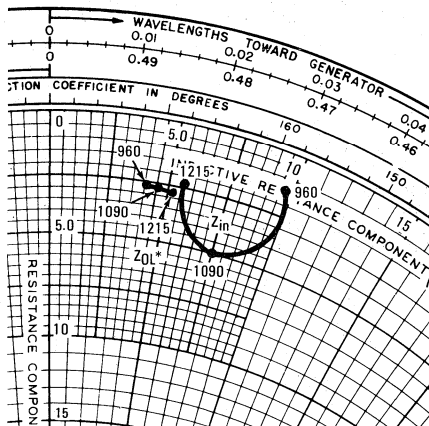


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

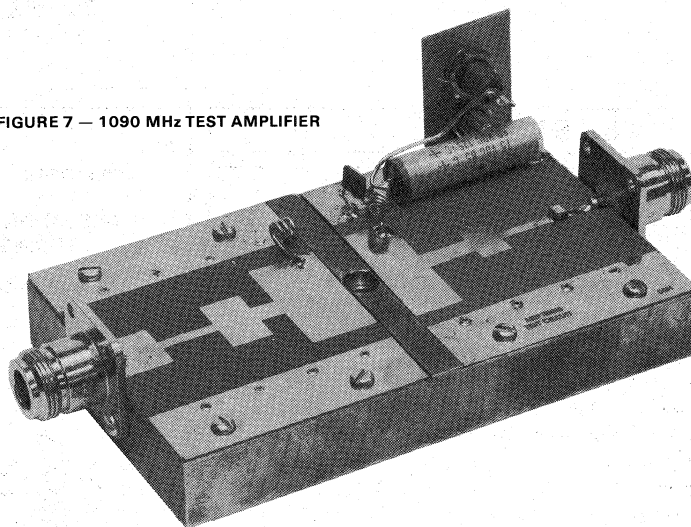


$P_{out} = 150 \text{ W pk}$ $V_{CC} = 50 \text{ V}$
 $t_p = 10 \mu s$ $D = 1\%$

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
960	$1.5 + j9.6$	$2.6 + j4.1$
1090	$5.0 + j7.5$	$2.7 + j4.6$
1215	$2.4 + j5.6$	$2.8 + j5.3$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER



2

FIGURE 8 — TYPICAL PULSE PERFORMANCE

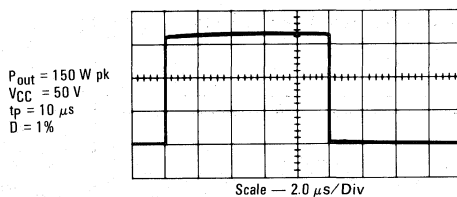
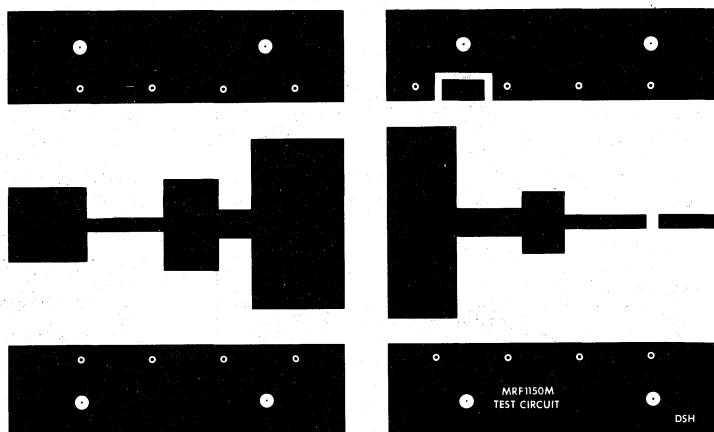


FIGURE 9 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



⊙ Soldered Eyelet

NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

MICROWAVE PULSE POWER TRANSISTOR

... designed for Class B and C *common base* amplifier applications in short pulse TACAN, IFF, and DME transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
Output Power = 250 Watts Peak
Minimum Gain = 6.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized for Long Life and Resistance to Metal Migration
- Compatible with Other 1250M Types
- Internal Input and Output Matching for Broadband Operation

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V _{CB0}	70	Vdc
Emitter-Base Voltage	V _{EB0}	4.0	Vdc
Collector-Current — Peak (1, 2)	I _C	24	Adc
Peak Device Dissipation @ T _C = 25°C (1, 2) Derate above 25°C	P _D	1166 6.67	Watts W/°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1,2,3)	R _{θJC}	0.15	°C/W

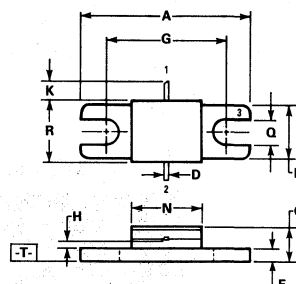
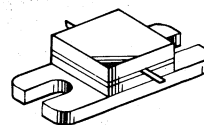
- (1) Pulse Width = 10 μs, Duty Cycle = 1%.
(2) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF short pulse amplifier.
(3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF1250M

250 W PEAK, 1020-1150 MHz

MICROWAVE POWER TRANSISTOR

NPN SILICON



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

- NOTES:
1. DIMENSIONS A, B AND R ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
Ⓢ 0.76 (0.030) Ⓢ T | A Ⓢ B Ⓢ
POSITIONAL TOLERANCE FOR LEADS:
Ⓢ 0.25 (0.010) Ⓢ T | A Ⓢ R Ⓢ
3. -T- IS BOTH A SEATING PLANE AND A DATUM SURFACE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MIN	MAX	MIN	MAX
A	22.61	23.11	0.890	0.910
B	9.65	9.91	0.380	0.390
C	4.06	5.84	0.160	0.230
D	0.51	0.76	0.020	0.030
E	1.40	1.65	0.055	0.065
G	16.51 BSC		0.650 BSC	
H	1.14	1.77	0.045	0.070
K	2.54		0.100	
N	9.91	10.41	0.390	0.410
Q	3.00	3.61	0.118	0.142
R	9.91	10.41	0.390	0.410

CASE 336-03

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, V _{BE} = 0)	V _{(BR)CES}	70	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 100 mAdc, I _E = 0)	V _{(BR)CBO}	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 mAdc, I _C = 0)	V _{(BR)EBO}	4.0	—	—	Vdc
Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0)	I _{CBO}	—	—	20	mAdc

ON CHARACTERISTICS

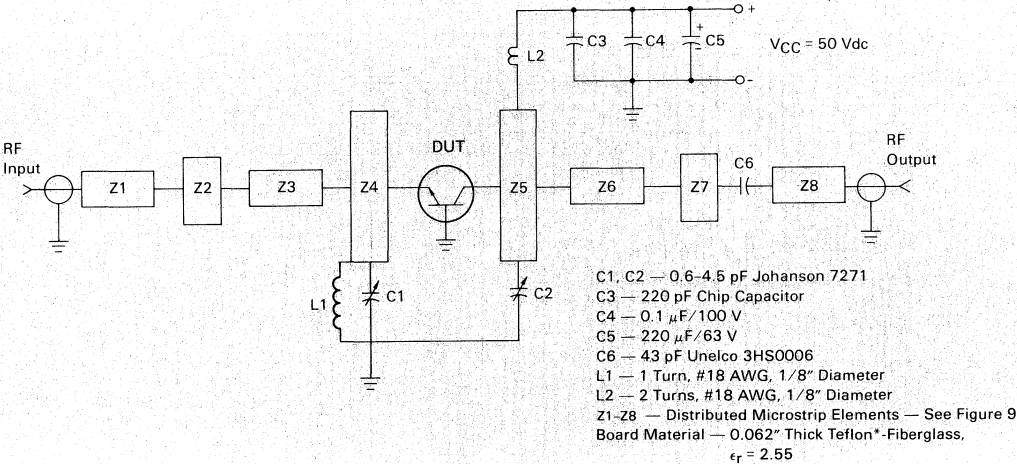
DC Current Gain* (I _C = 10 Adc, V _{CE} = 5.0 Vdc)	h _{FE}	10	30	—	—
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FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)

Common-Base Amplifier Power Gain (V _{CC} = 50 Vdc, P _{out} = 250 W pk, f = 1090 MHz)	G _{PB}	6.0	7.2	—	dB
Collector Efficiency (V _{CC} = 50 Vdc, P _{out} = 250 W pk, f = 1090 MHz)	η	33	—	—	%
Load Mismatch (V _{CC} = 50 Vdc, P _{out} = 250 W pk, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output.			

*80 μs Pulse on Tektronix 576 or equivalent.

FIGURE 1 — 1090 MHz TEST CIRCUIT



*Registered Trademark of DuPont

FIGURE 2 — OUTPUT POWER versus INPUT POWER

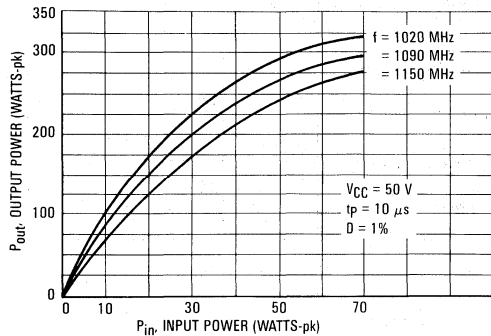


FIGURE 3 — OUTPUT POWER versus FREQUENCY

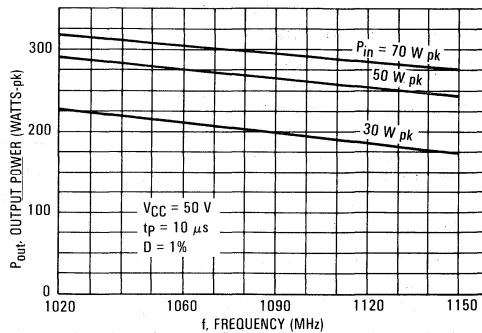


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

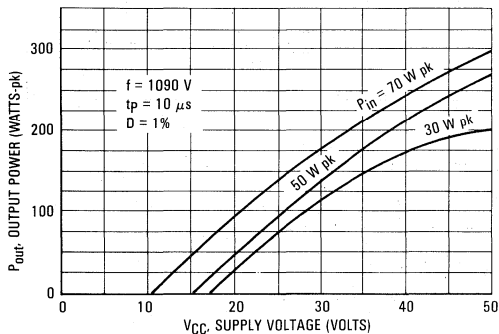


FIGURE 5 — POWER GAIN versus FREQUENCY

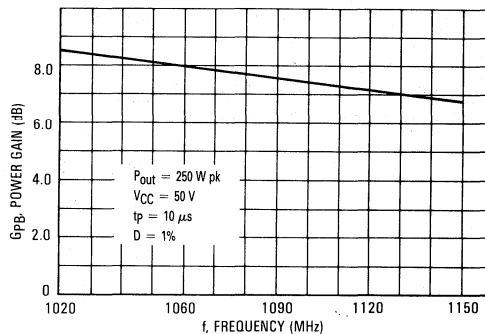
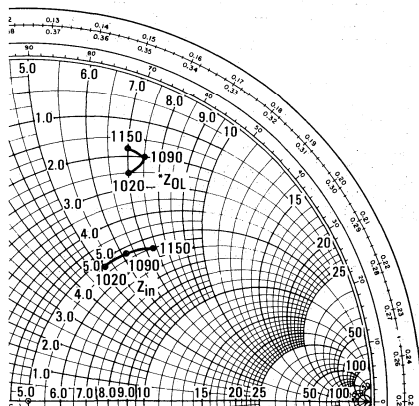


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

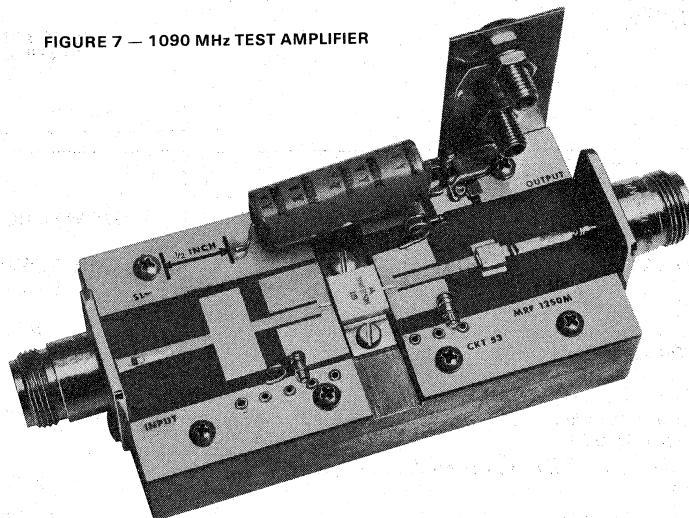


$P_{out} = 250 \text{ W-pk}$ $V_{CC} = 50 \text{ V}$
 $t_p = 10 \mu s$ $D = 1\%$

f MHz	Z_{in} Ohms	Z_{out}^* Ohms
1020	$5.2 + j5.2$	$2.5 + j7.0$
1090	$5.2 + j6.2$	$2.0 + j7.5$
1150	$5.5 + j7.3$	$1.8 + j7.0$

* Z_{out} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

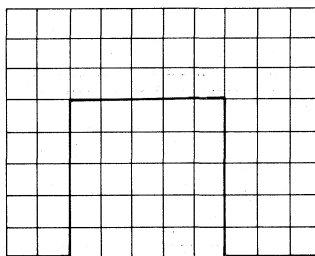
FIGURE 7 — 1090 MHz TEST AMPLIFIER



2

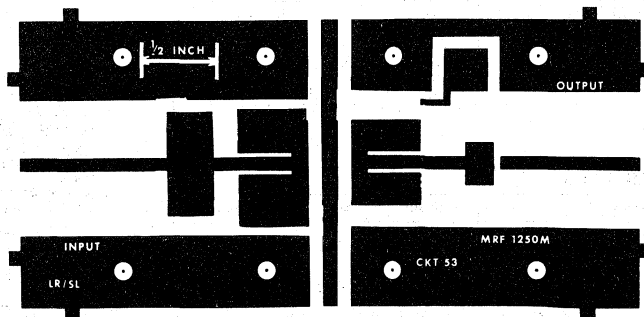
FIGURE 8 — TYPICAL PULSE PERFORMANCE

$P_{out} = 250 \text{ W pk}$
 $f = 1090 \text{ MHz}$
 $V_{CC} = 50 \text{ V}$
 $t_p = 10 \mu s$
 $D = 1\%$



Scale — $2.0 \mu s/Div$

FIGURE 9 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



⊙ Soldered Eyelet

NOTE: The Printed Circuit Board shown is 75% of the original.

MRF1325M

The RF Line

MICROWAVE PULSE POWER TRANSISTOR

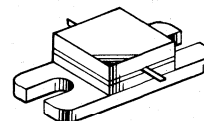
... designed for Class B and C *common base* amplifier applications in short pulse TACAN, IFF, and DME transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
Output Power = 325 Watts Peak
Minimum Gain = 6.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized for Long Life and Resistance to Metal Migration
- Compatible with Other 1325M Types
- Internal Input and Output Matching for Broadband Operation

325 W PEAK, 1020-1150 MHz

MICROWAVE POWER TRANSISTOR

NPN SILICON



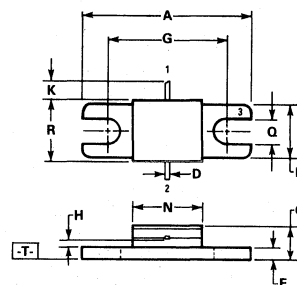
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Peak (1, 2)	I_C	24	Adc
Peak Device Dissipation @ $T_C = 25^\circ\text{C}$ (1, 2) Derate above 25°C	P_D	1166 6.67	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1,2,3)	$R_{\theta JC}$	0.15	$^\circ\text{C}/\text{W}$

- (1) Pulse Width = 10 μs , Duty Cycle = 1%.
(2) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF short pulse amplifier.
(3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

NOTES:

- DIMENSIONS A, B AND R ARE DATUMS.
- POSITIONAL TOLERANCE FOR MOUNTING HOLES:
 $\pm 0.76 (0.030) \text{ T A } \text{B}$
- POSITIONAL TOLERANCE FOR LEADS:
 $\pm 0.25 (0.010) \text{ T A } \text{R}$
- T IS BOTH A SEATING PLANE AND A DATUM SURFACE.
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.61	23.11	0.890	0.910
B	9.65	9.91	0.380	0.390
C	4.06	5.84	0.160	0.230
D	0.51	0.76	0.020	0.030
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G	16.51	BSC	0.650	BSC
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K	2.54	—	0.100	—
N	9.91	10.41	0.390	0.410
Q	3.00	3.61	0.118	0.142
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CASE 336-03

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Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, V _{BE} = 0)	V _{(BR)CES}	70	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 100 mAdc, I _E = 0)	V _{(BR)CBO}	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 10 mAdc, I _C = 0)	V _{(BR)EBO}	4.0	—	—	Vdc
Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0)	I _{CBO}	—	—	20	mAdc

ON CHARACTERISTICS

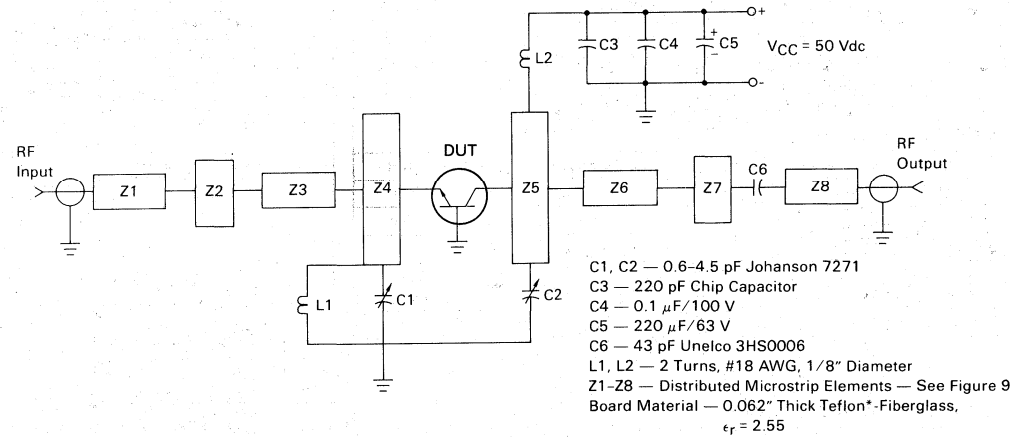
DC Current Gain* (I _C = 10 Adc, V _{CE} = 5.0 Vdc)	h _{FE}	10	30	—	—
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FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)

Common-Base Amplifier Power Gain (V _{CC} = 50 Vdc, P _{out} = 325 W pk, f = 1090 MHz)	G _{PB}	6.0	7.2	—	dB
Collector Efficiency (V _{CC} = 50 Vdc, P _{out} = 325 W pk, f = 1090 MHz)	η	33	—	—	%
Load Mismatch (V _{CC} = 50 Vdc, P _{out} = 325 W pk, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

*80 μs Pulse on Tektronix 576 or equivalent.

FIGURE 1 — 1090 MHz TEST CIRCUIT



*Registered Trademark of DuPont

FIGURE 2 — OUTPUT POWER versus INPUT POWER

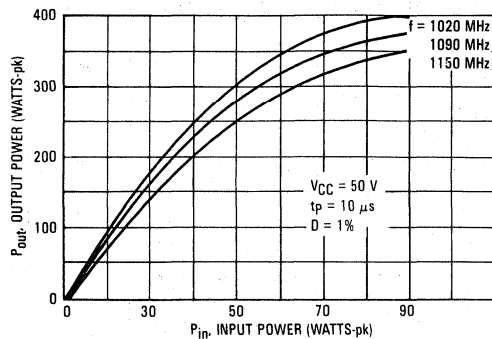


FIGURE 3 — OUTPUT POWER versus FREQUENCY

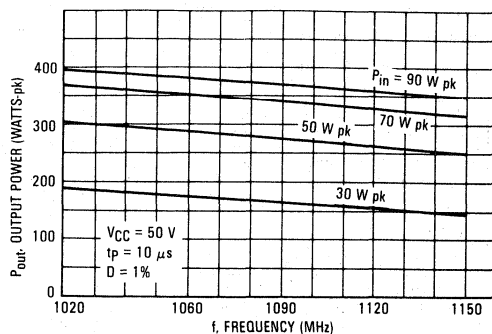


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

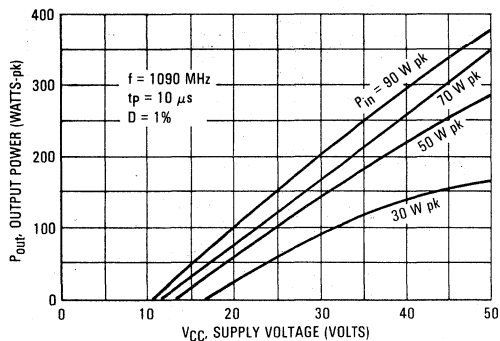


FIGURE 5 — POWER GAIN versus FREQUENCY

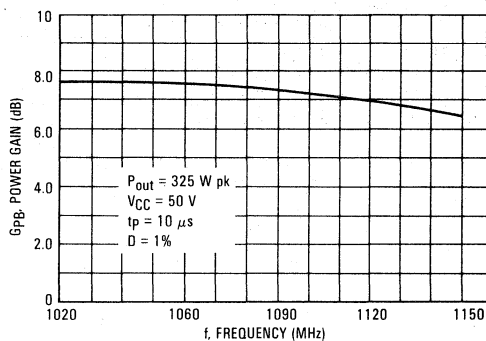
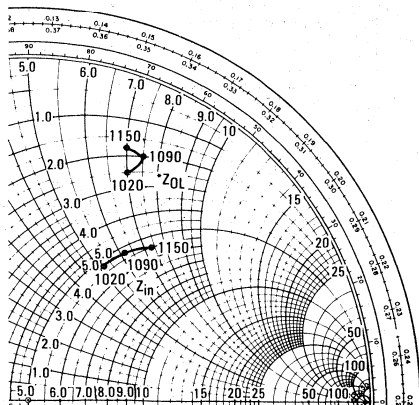


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



$P_{out} = 325 \text{ W-pk}$ $V_{CC} = 50 \text{ V}$
 $t_p = 10 \mu s$ $D = 1\%$

f MHz	Z_{in} Ohms	Z_{out}^* Ohms
1020	$5.2 + j5.2$	$2.5 + j7.0$
1090	$5.2 + j6.2$	$2.0 + j7.5$
1150	$5.5 + j7.3$	$1.8 + j7.0$

* Z_{out}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER

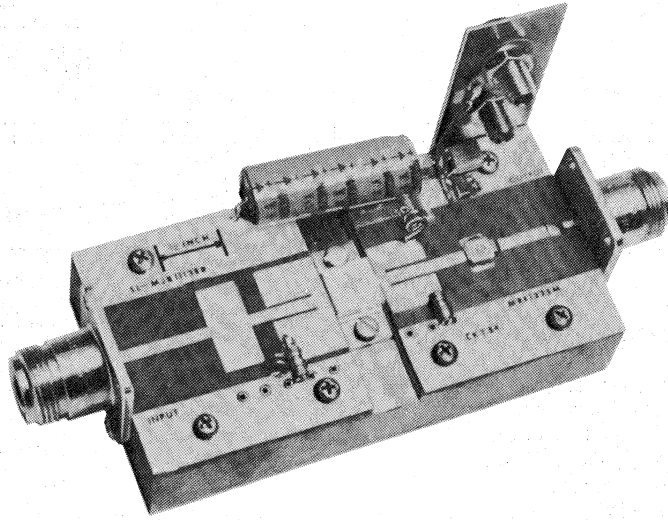


FIGURE 8 — TYPICAL PULSE PERFORMANCE

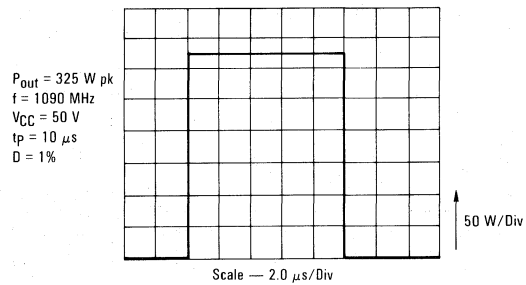
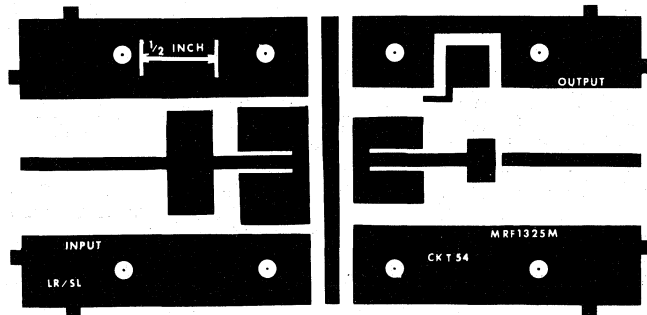


FIGURE 9 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



⊙ Soldered Eyelet

NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

NPN SILICON POWER TRANSISTORS

Designed for 12.5 volt large-signal power amplifiers in commercial and industrial equipment.

- High Common Emitter Power Gain
- Specified 12.5 V, 175 MHz Performance
Output Power = 30 Watts
Power Gain = 10 dB
Efficiency = 60%
- Diffused Emitter Resistor Ballasting
- Characterized to 220 MHz
- Load Mismatch at High Line and Overdrive Conditions

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	8.0	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	100 0.57	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

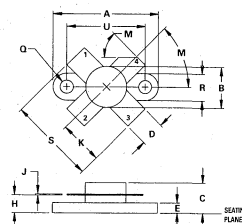
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	$^\circ\text{C/W}$

MRF1946 MRF1946A

30 W 136–220 MHz

RF POWER TRANSISTORS

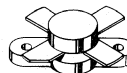
NPN SILICON



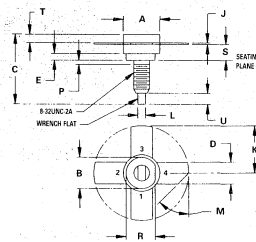
NOTES:
1. DIMENSIONING AND TOLERANCING PER
ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	24.25	25.14	0.950	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.98	0.215	0.235
E	2.16	2.68	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.94	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.43	6.47	0.255	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

STYLE 1:
PIN 1: EMITTER
2: BASE
3: EMITTER
4: COLLECTOR



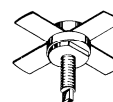
CASE 211-07
MRF1946



NOTES:
1. DIMENSIONING AND TOLERANCING PER
ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	6.13	6.38	0.240	0.250
C	17.02	20.07	0.669	0.790
D	5.46	5.97	0.215	0.235
E	1.28	—	0.050	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45°	NOM	45°	NOM
P	—	1.27	—	0.050
R	7.50	7.80	0.295	0.307
S	4.07	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.48	3.35	0.098	0.132

STYLE 1:
PIN 1: EMITTER
2: BASE
3: EMITTER
4: COLLECTOR



CASE 145A-09
MRF1946A

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	5.0	mA _{dc}
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ Adc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	40	75	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	75	100	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 175\text{ MHz}$)	G_{pe}	10	11	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 30\text{ W}$, $f = 175\text{ MHz}$)	η	60	70	—	%
Load Mismatch ($V_{CC} = 15.5\text{ Vdc}$, $P_{in} = 2.0\text{ dB Overdrive}$, Load VSWR = 30:1)	ψ	No Degradation in Output Power			

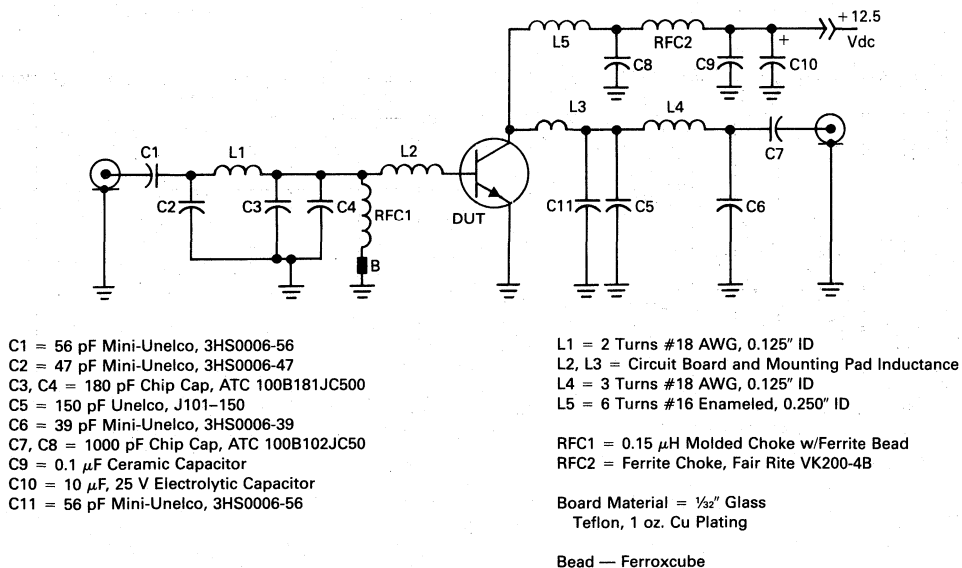
FIGURE 1 — BROADBAND TEST CIRCUIT SCHEMATIC

FIGURE 2 — OUTPUT POWER versus INPUT POWER

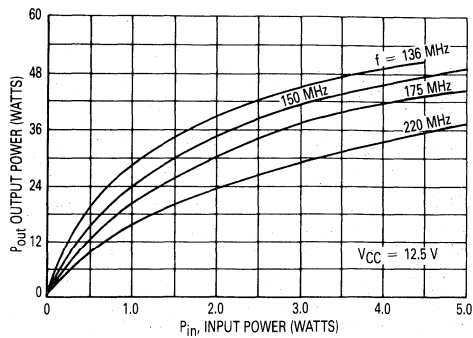


FIGURE 3 — OUTPUT POWER versus FREQUENCY

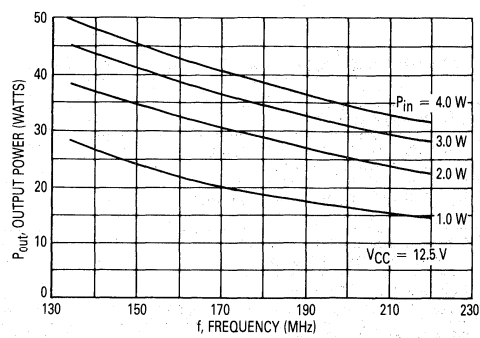


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 220$ MHz

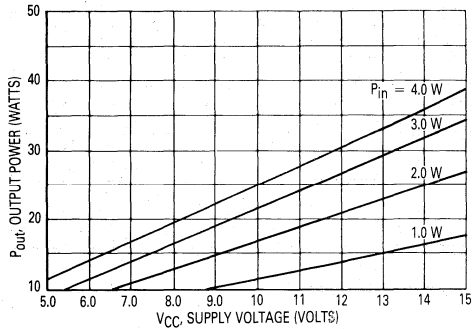


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 175$ MHz

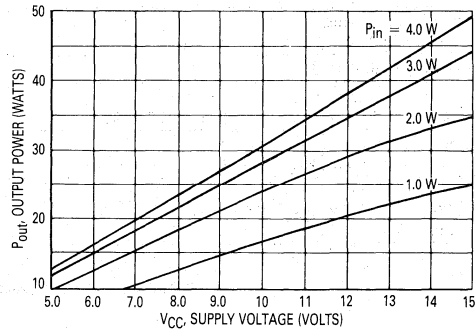


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 150$ MHz

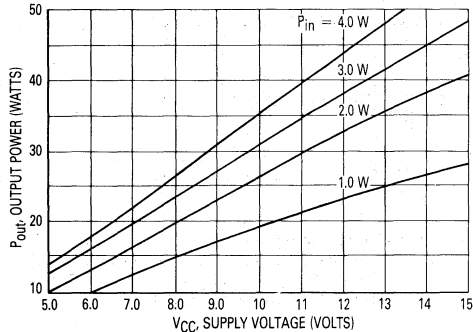


FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 136$ MHz

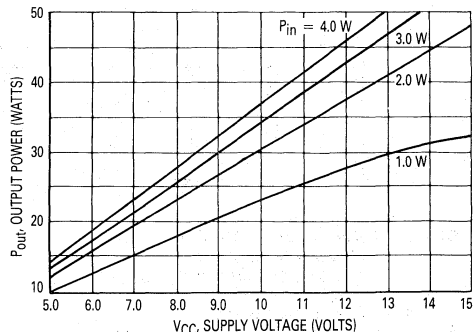


FIGURE 8 — TYPICAL PERFORMANCE IN A BROADBAND CIRCUIT

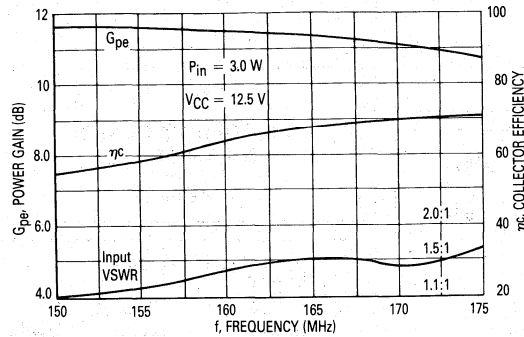
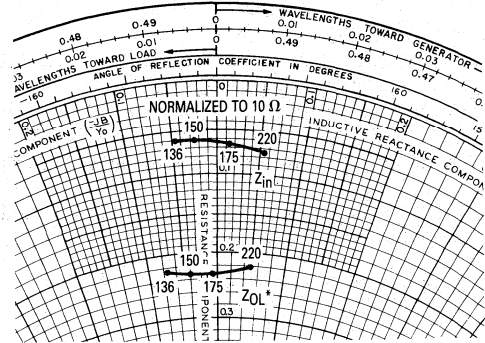


FIGURE 9 — SERIES EQUIVALENT INPUT AND OUTPUT IMPEDANCE

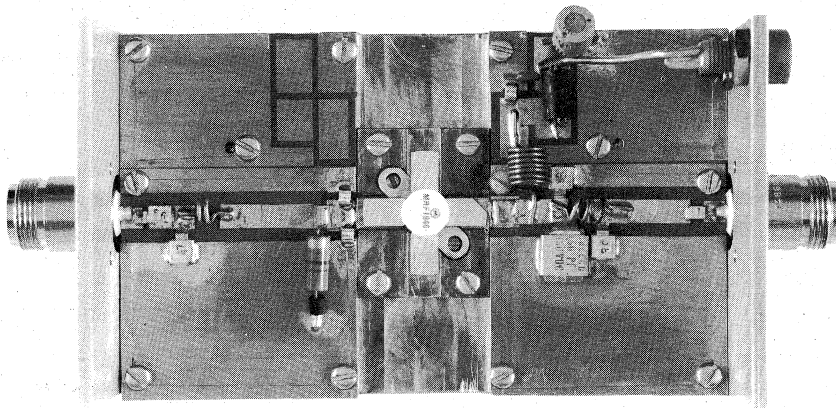


$V_{CC} = 12.5 \text{ Vdc}$, $P_{out} = 30 \text{ W}$

f MHz	Z_{in} Ohms	Z_{out}^* Ohms
136	$0.60 - j0.48$	$2.22 - j0.74$
150	$0.63 - j0.26$	$2.30 - j0.40$
175	$0.62 + j0.13$	$2.35 - j0.04$
220	$0.73 + j0.57$	$2.20 + j0.43$

* Z_{out} = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

FIGURE 10 — BROADBAND TEST CIRCUIT



The RF Line

NPN SILICON MICROWAVE POWER TRANSISTORS

... designed for Class B and C amplifier or oscillator applications in the 1.0 to 2.3 GHz frequency range.

- Guaranteed Performance @ 2 GHz, 28 Vdc
 Output Power = 1.0 Watt
 Minimum Gain = 9.0 dB
- 100% Tested for Load Mismatch at All Phase Angles
 With 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and
 Resistance to Metal Migration
- Compatible with Older 2001 Types
- Other Devices in the 2000 Series:
 MRF2003 3 W
 MRF2005 5 W
 MRF2010 10 W

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	250	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	7.0 40	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	$^\circ\text{C}/\text{W}$

- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF2001 MRF2001B

1.0 W 2 GHz

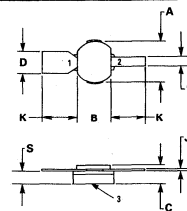
MICROWAVE POWER TRANSISTORS

NPN SILICON



MRF2001B

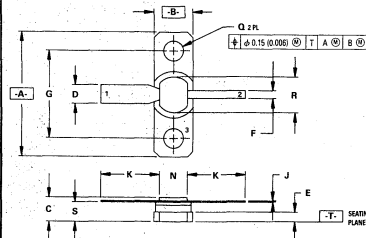
MRF2001



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.72	5.97	0.225	0.235
B	4.44	4.70	0.175	0.185
C	2.29	2.74	0.090	0.108
D	2.92	3.18	0.115	0.125
F	1.14	1.40	0.045	0.055
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
S	1.52	1.78	0.060	0.070

STYLE 1:
 PIN 1. EMITTER
 2. COLLECTOR
 3. BASE

CASE 328-02



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI
 Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

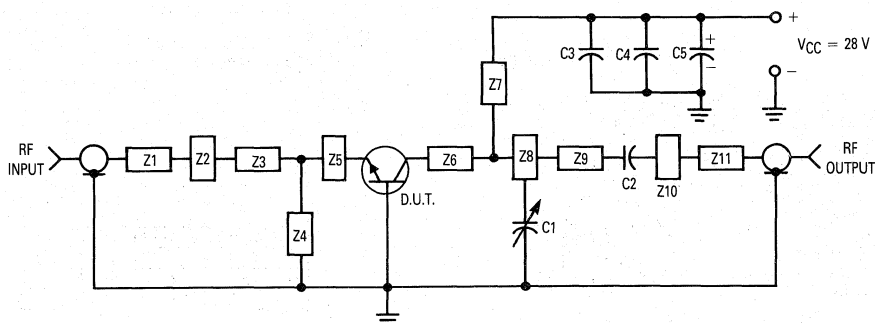
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.20	20.57	0.795	0.810
B	6.23	6.47	0.245	0.255
C	3.69	4.31	0.145	0.170
D	2.93	3.17	0.115	0.125
E	1.40	1.77	0.055	0.070
F	1.15	1.39	0.045	0.055
G	14.22 BSC	—	0.560 BSC	—
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
N	4.45	4.89	0.175	0.195
Q	3.05	3.42	0.120	0.135
R	5.72	5.97	0.225	0.235
S	2.93	3.55	0.115	0.140

STYLE 1:
 PIN 1. EMITTER
 2. COLLECTOR
 3. BASE

CASE 328A-02

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	2.5	5.0	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 2.0\text{ GHz}$)	G_{PB}	9.0	10	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 2.0\text{ GHz}$)	η	30	35	—	%
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 2.0\text{ GHz}$, $VSWR = 10:1$ All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1. 2 GHz TEST CIRCUIT

Z1–Z11 — Microstrip
 C1 — 0.4–2.5 pF Johanson 7285
 C2, C3 — 56 pF Chip Capacitor
 C4 — 0.1 μF
 C5 — 10 μF 50 V Electrolytic
 Board Material — 0.062" Glass Teflon

FIGURE 2 – OUTPUT POWER versus INPUT POWER
(f = 1 GHz)

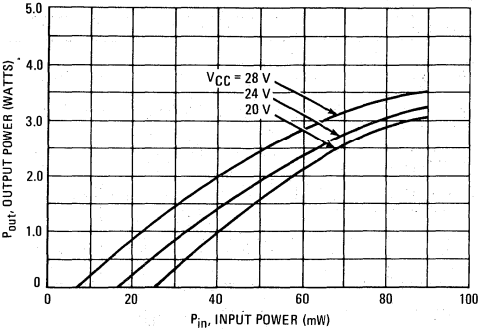


FIGURE 3 – OUTPUT POWER versus INPUT POWER
(f = 2 GHz)

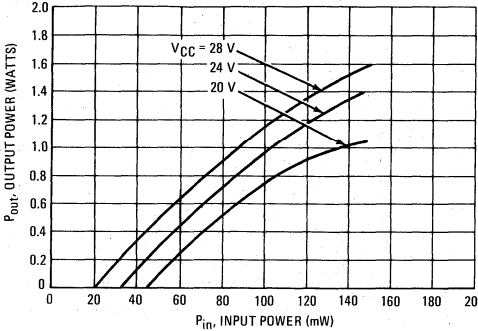


FIGURE 4 – OUTPUT POWER versus FREQUENCY

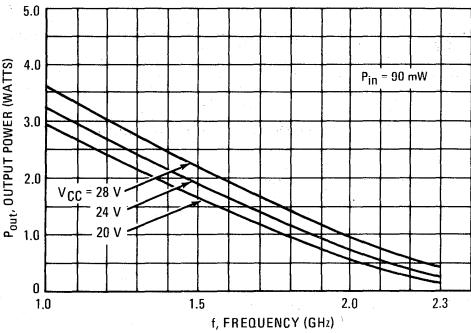


FIGURE 5 – POWER GAIN versus FREQUENCY

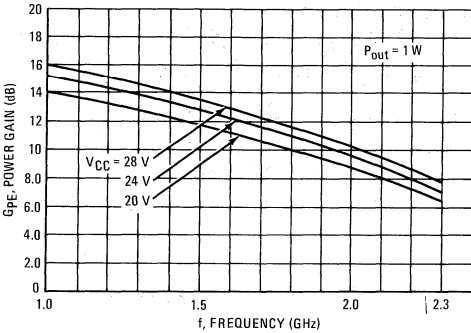
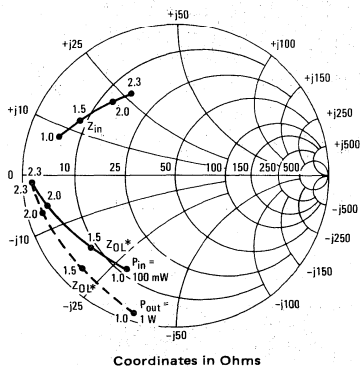


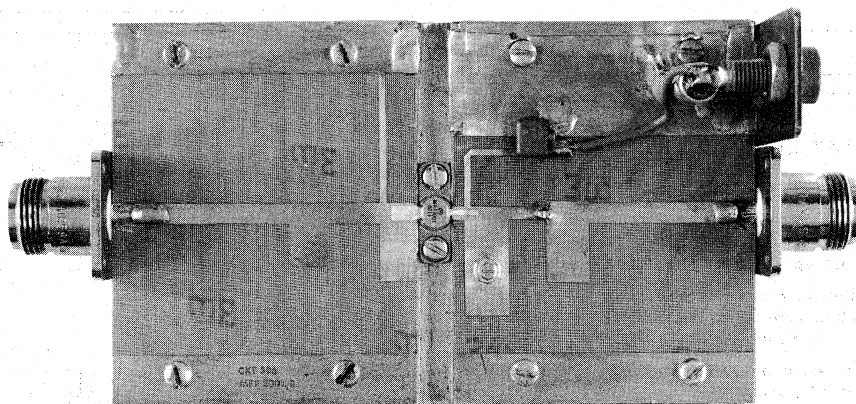
FIGURE 6 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



V _{CC} = 28 V					
f	Z _{in}	Z _{0L} *	P _{in}	Z _{0L} *	P _{out}
1.0	6.6 + j8.4	11 - j28.9	100 mW	4.9 - j37.4	1 W
1.5	8.5 + j12.2	8.1 - j17.3		4.6 - j21.0	
2.0	11.5 + j19.5	4.2 - j6.0		3.5 - j7.0	
2.3	13.4 + j26.0	3.4 - j1.8		3.4 - j1.8	

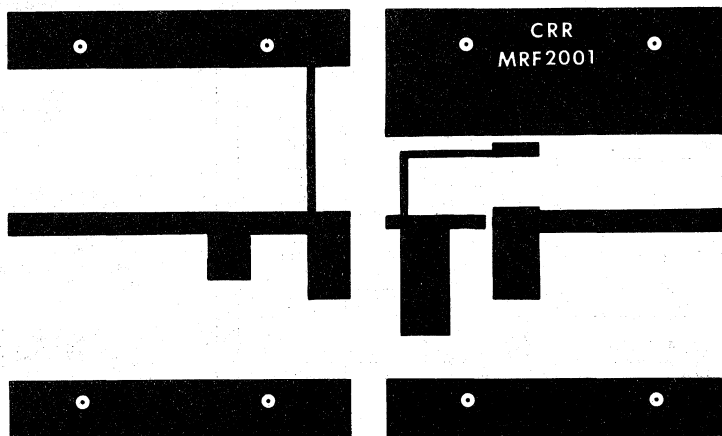
*Z_{0L} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — 2 GHz TEST AMPLIFIER



2

FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2 GHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF2001M

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

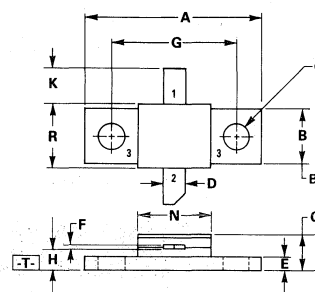
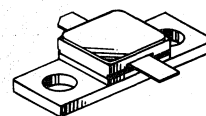
... designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
Output power = 1.0 Watt
Minimum Gain = 8.5 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

1.0 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON



STYLE 1:
 PIN 1, EMITTER
 2, COLLECTOR
 3, BASE

- NOTES:
1. DIMENSIONS [A] AND [B] ARE DATUMS.
 2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
 $\pm 0.13 (0.005) \text{ } \textcircled{M} \text{ } \textcircled{T} \text{ } \textcircled{A} \text{ } \textcircled{B} \text{ } \textcircled{Q}$
 3. [T] IS SEATING PLANE.
 4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	250	mA dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	7.0 40	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
 (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

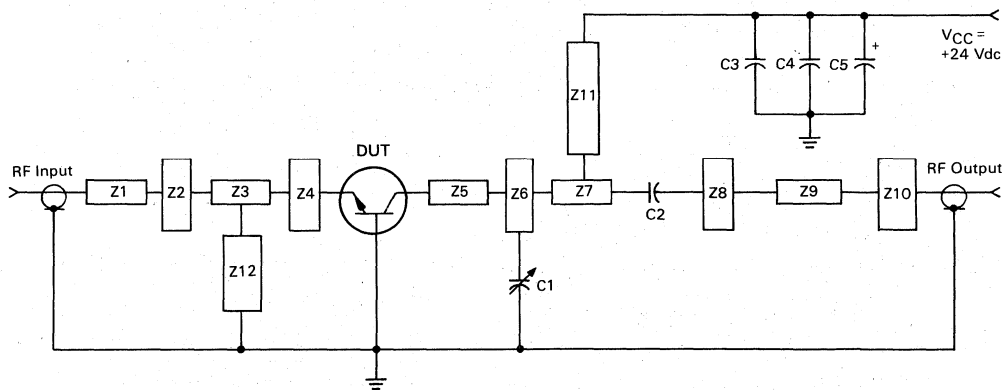
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.48	6.73	0.255	0.265
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
F	0.05	0.15	0.002	0.006
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 24\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	4.0	6.0	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 2.0\text{ GHz}$)	G_{PB}	8.5	9.5	—	dB
Collector Efficiency ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 2.0\text{ GHz}$)	η	35	40		
Load Mismatch ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 1.0\text{ W}$, $f = 2.0\text{ GHz}$, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2.0 GHz TEST CIRCUIT



Z1-Z12 — Microstrip, See Photomaster
C1 — 0.6–4.5 pF Johanson 7271
C2, C3 — 56 pF Chip Capacitor
C4 — 0.1 μF
C5 — 10 μF , 35 V
Board Material — 0.0312" Teflon Fiberglass
 $\epsilon_r = 2.5 \pm 0.05$

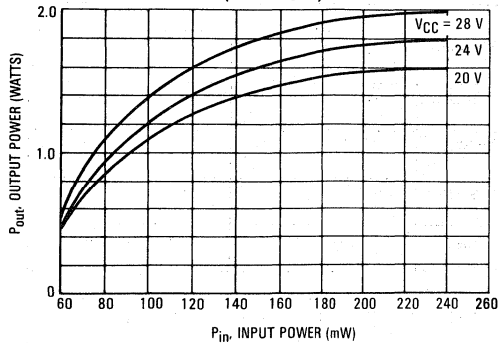
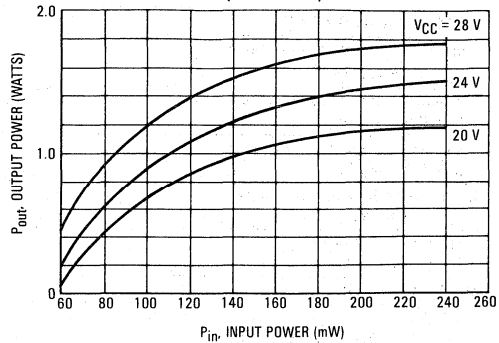
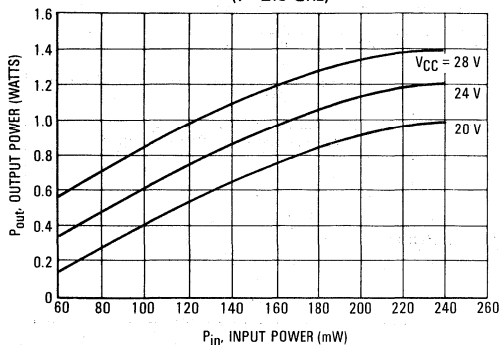
FIGURE 2 — OUTPUT POWER versus INPUT POWER
($f = 1.7$ GHz)FIGURE 3 — OUTPUT POWER versus INPUT POWER
($f = 2.0$ GHz)FIGURE 4 — OUTPUT POWER versus INPUT POWER
($f = 2.3$ GHz)

FIGURE 5 — POWER GAIN versus FREQUENCY

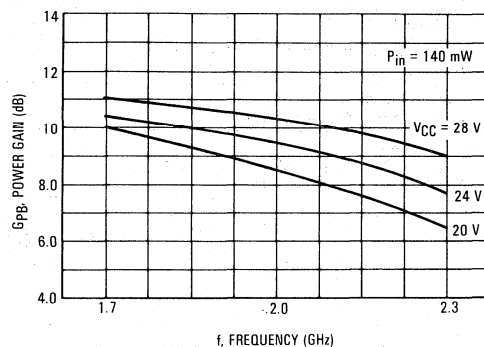
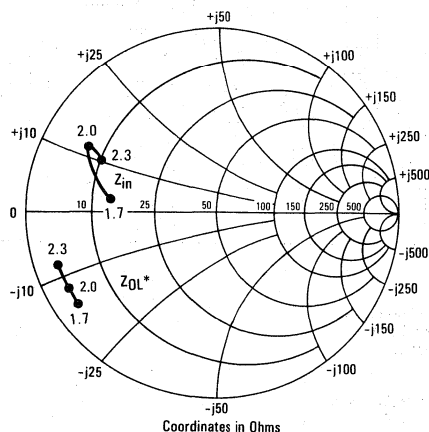


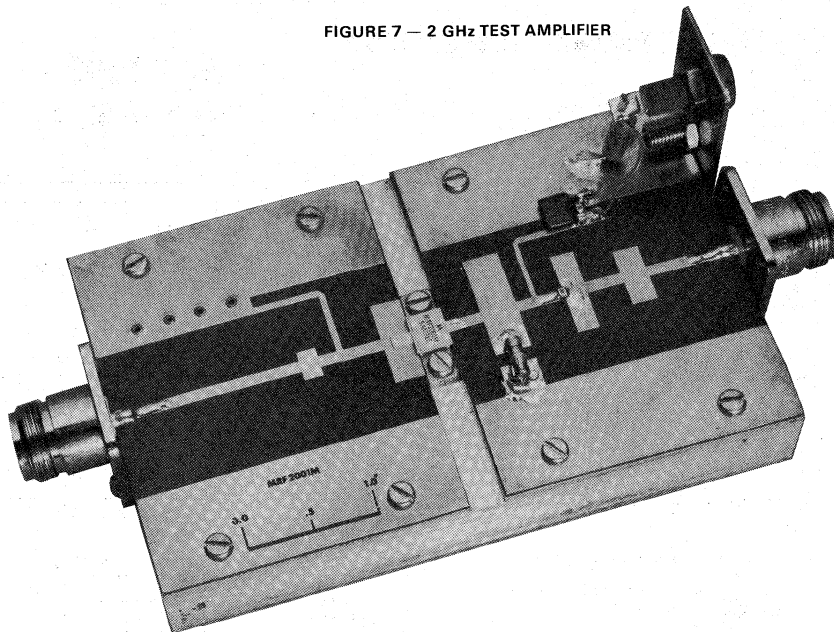
FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

 $V_{CC} = 24$ V, $P_{in} = 140$ mW

f GHz	Z_{in} Ohms	Z_{OL}^* Ohms
1.7	$15.5 + j 3.0$	$4.5 - j 15.0$
2.0	$7.5 + j 11.0$	$4.0 - j 12.0$
2.3	$10.0 + j 10.0$	$3.0 - j 7.0$

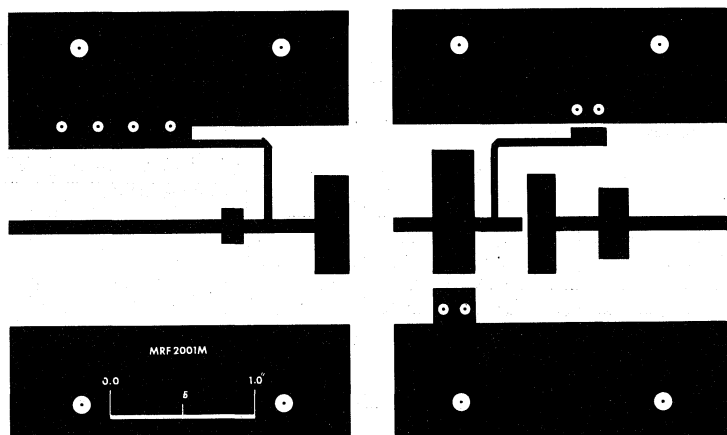
* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — 2 GHz TEST AMPLIFIER



2

FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2.0 GHz TEST CIRCUIT



⊙ Denotes Eyelet

⊙ 4-40 Screw Placement

NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTORS

... designed for Class B and C amplifier or oscillator applications in the 1.0 to 2.3 GHz frequency range.

- Guaranteed Performance @ 2 GHz, 28 Vdc
Output Power = 3.0 Watts
Minimum Gain = 7.8 dB
- 100% Tested for Load Mismatch at All Phase Angles
With 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and
Resistance to Metal Migration
- Compatible with Older 2003 Types
- Other Devices in the 2000 Series:
MRF2001 1 W
MRF2005 5 W
MRF2010 10 W

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	11.6 67	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	15	$^\circ\text{C}/\text{W}$

- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF2003 MRF2003B

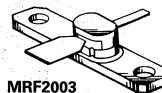
3.0 W 2 GHz

MICROWAVE POWER TRANSISTORS

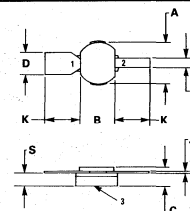
NPN SILICON



MRF2003B



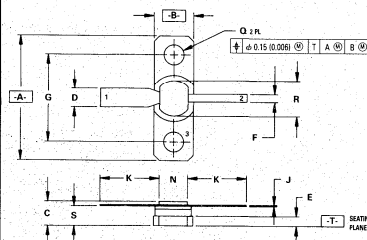
MRF2003



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.72	5.97	0.225	0.235
B	4.44	4.70	0.175	0.185
C	2.29	2.74	0.090	0.108
D	2.92	3.18	0.115	0.125
F	1.14	1.40	0.045	0.055
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
S	1.52	1.78	0.060	0.070

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

CASE 328-02



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.20	20.57	0.795	0.810
B	6.23	6.47	0.245	0.255
C	3.69	4.31	0.145	0.170
D	2.93	3.17	0.115	0.125
E	1.40	1.77	0.055	0.070
F	1.15	1.39	0.045	0.055
G	14.22 BSC	0.560 BSC		
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
N	4.45	4.69	0.175	0.185
Q	3.05	3.42	0.120	0.135
R	5.72	5.97	0.225	0.235
S	2.93	3.55	0.115	0.140

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

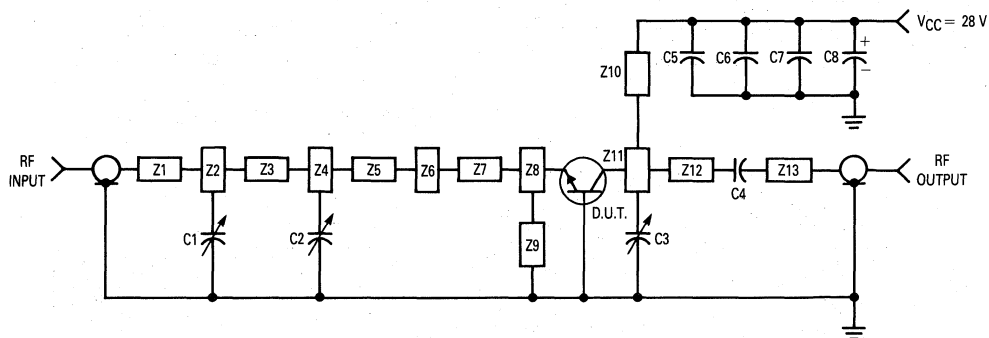
CASE 328A-02

MRF2003, MRF2003B

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CEr}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 150\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	4.0	6.0	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 3.0\text{ W}$, $f = 2.0\text{ GHz}$)	G_{PB}	7.8	8.9	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 3.0\text{ W}$, $f = 2.0\text{ GHz}$)	η	30	35	—	—
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 3.0\text{ W}$, $f = 2.0\text{ GHz}$, $VSWR = 10:1$ All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2 GHz TEST CIRCUIT



Z1-Z13 — Microstrip
 C1, C2, C3 — 0.4-2.5 pF Johanson
 C4, C5, C6 — 56 pF Chip Capacitor
 C7 — 0.1 μF
 C8 — 10 μF 50 V Electrolytic
 Board Material — 0.062" Glass Teflon

FIGURE 2 – OUTPUT POWER versus INPUT POWER
($f = 1 \text{ GHz}$)

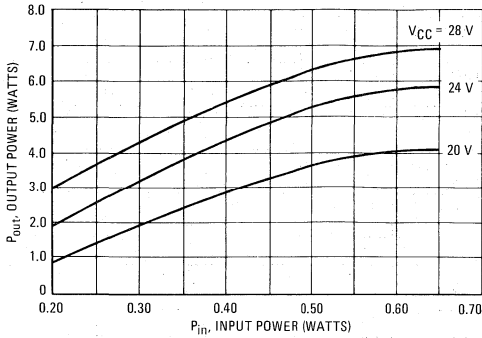


FIGURE 3 – OUTPUT POWER versus INPUT POWER
($f = 2 \text{ GHz}$)

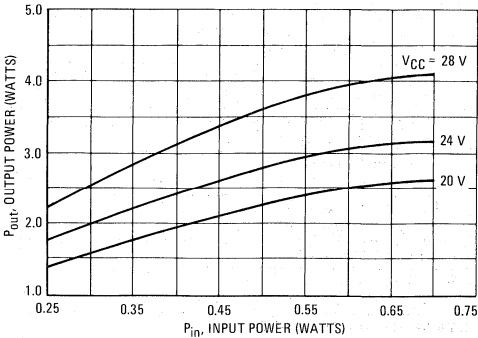


FIGURE 4 – OUTPUT POWER versus FREQUENCY

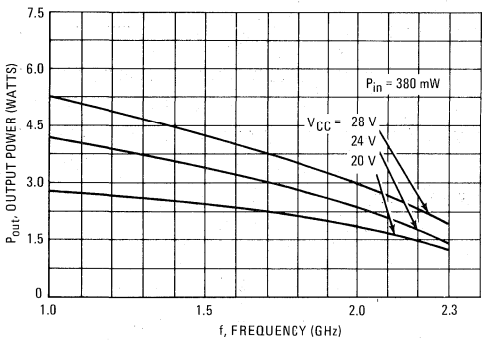


FIGURE 5 – POWER GAIN versus FREQUENCY

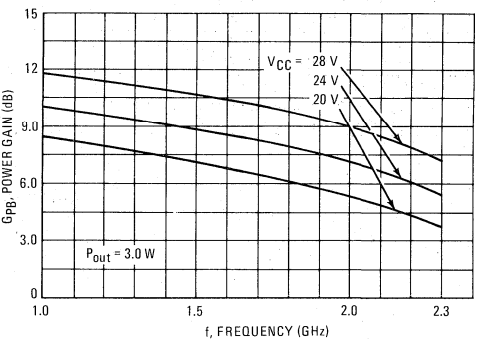
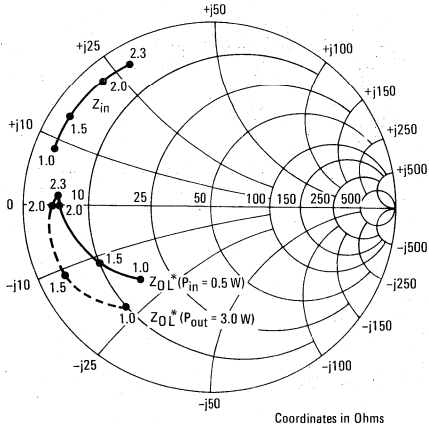


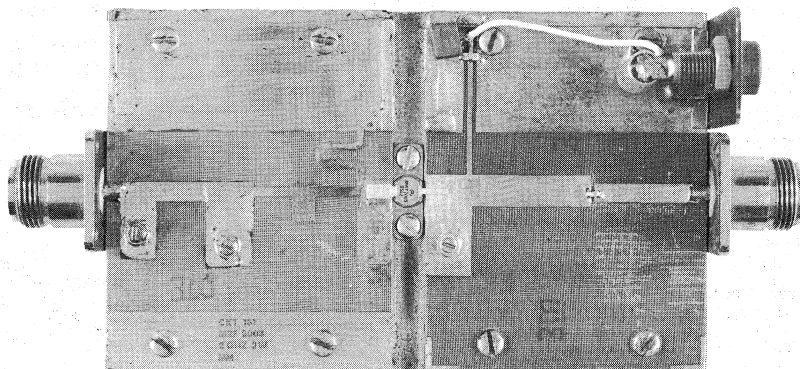
FIGURE 6 – MRF2003 SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



$V_{CC} = 28 \text{ V}$					
f GHz	Z_{in} Ohms	Z_{OL}^* Ohms	$P_{in} =$ 0.5 W	Z_{OL}^* Ohms	$P_{out} =$ 3 W
1.0	$2.0 + j9.0$	$17.5 - j18$		$10 - j23$	
1.5	$3.0 + j14.5$	$10 - j10.5$		$3.0 - j10.5$	
2.0	$4.0 + j23$	$6.5 + j0$		$5.0 + j0$	
2.3	$4.5 + j29$	$5.5 + j1.7$		$5.5 + j1.7$	

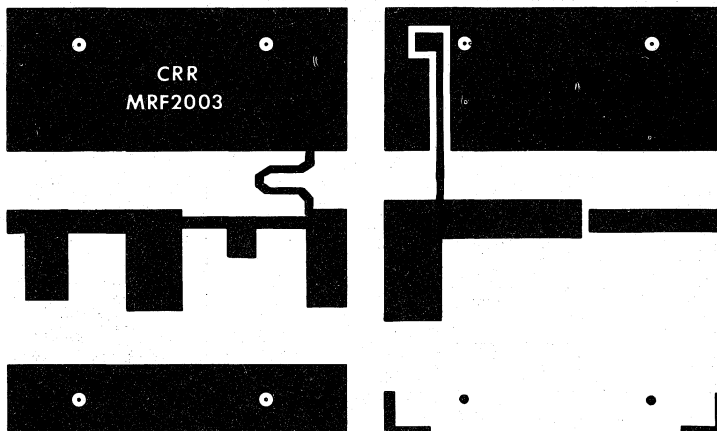
* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 – 2 GHz TEST AMPLIFIER



2

FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT
2 GHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF2003M

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

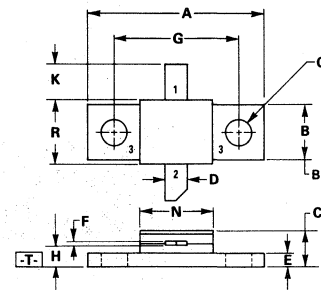
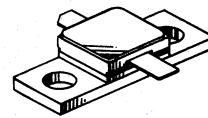
... designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
Output power = 3.0 Watt
Minimum Gain = 8.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

3.0 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON



STYLE 1:
 PIN 1. EMITTER
 PIN 2. COLLECTOR
 PIN 3. BASE

- NOTES:
1. DIMENSIONS [A] AND [B] ARE DATUMS.
 2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
 $\pm 0.13 (0.005) \text{ T A } \text{B}$
 3. [T] IS SEATING PLANE.
 4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.48	6.73	0.255	0.265
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
F	0.05	0.15	0.002	0.006
G	14.27	BSC	0.560	BSC
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	500	mA _{dc}
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	11 63	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

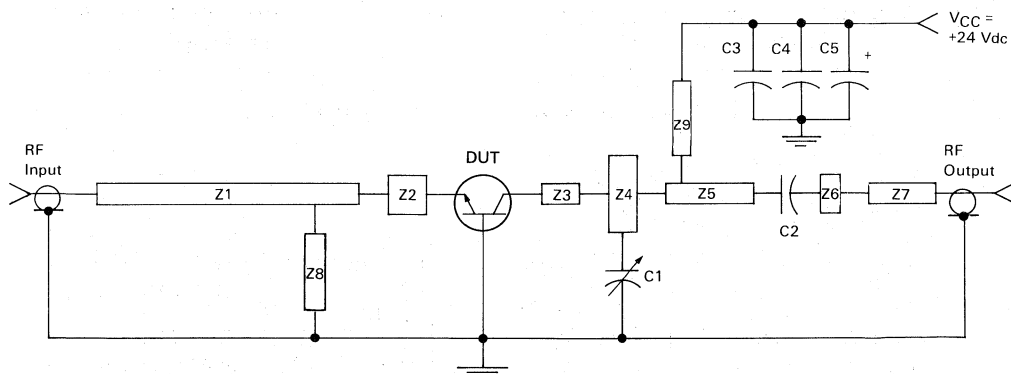
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	16	$^\circ\text{C}/\text{W}$

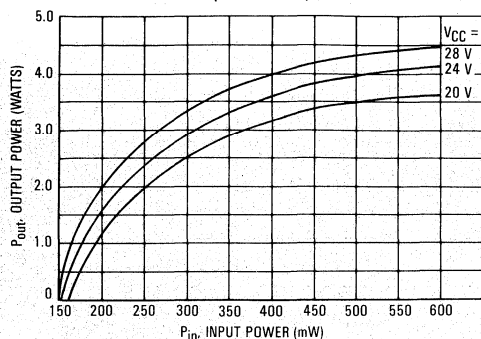
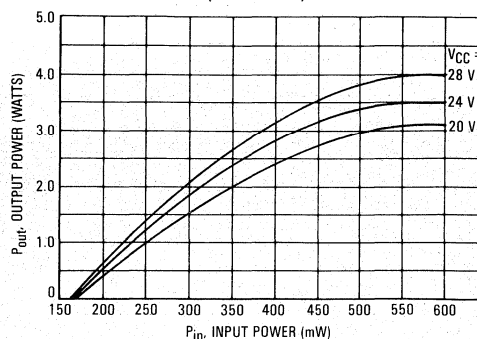
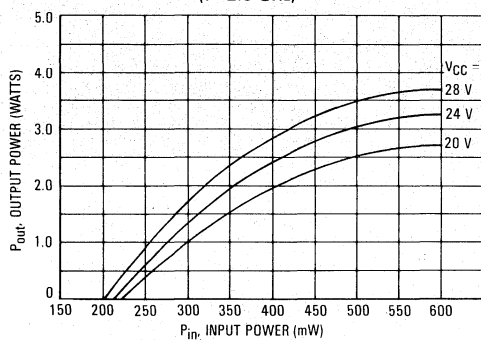
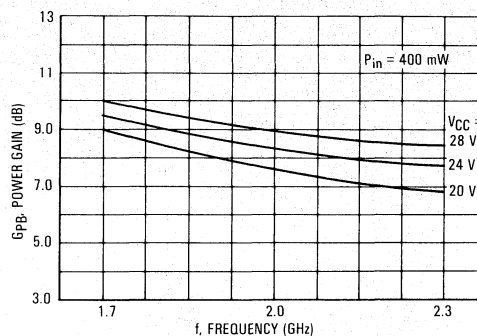
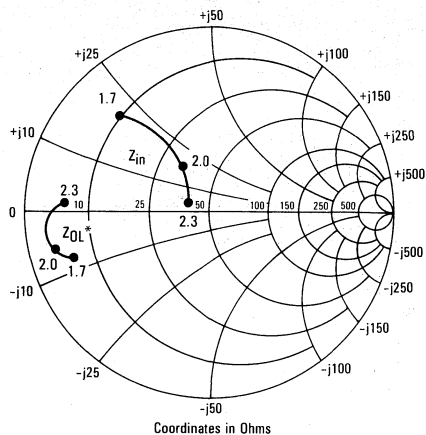
- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
 (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5.0\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 150\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 24\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	4.0	6.0	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 3.0\text{ W}$, $f = 2.0\text{ GHz}$)	G_{PB}	8.0	8.5	—	dB
Collector Efficiency ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 3.0\text{ W}$, $f = 2.0\text{ GHz}$)	η	35	40	—	—
Load Mismatch ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 3.0\text{ W}$, $f = 2.0\text{ GHz}$, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2.0 GHz TEST CIRCUIT

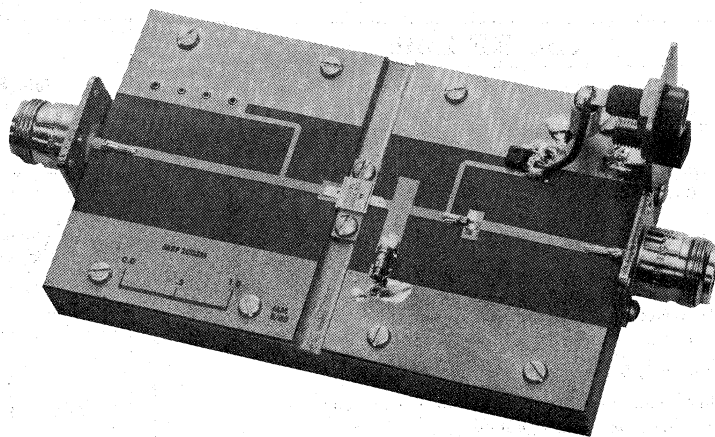
Z1-Z9 — Microstrip, See Photomaster
 C1 — 0.6-4.5 pF Johanson 7271
 C2, C3 — 56 pF Chip Capacitor
 C4 — 0.1 μF
 C5 — 10 μF , 35 V
 Board Material — 0.0312" Teflon Fiberglass
 $\epsilon_r = 2.5 \pm 0.05$

FIGURE 2 — OUTPUT POWER versus INPUT POWER
 (f = 1.7 GHz)

FIGURE 3 — OUTPUT POWER versus INPUT POWER
 (f = 2.0 GHz)

FIGURE 4 — OUTPUT POWER versus INPUT POWER
 (f = 2.3 GHz)

FIGURE 5 — POWER GAIN versus FREQUENCY

FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

 V_{CC} = 24 V, P_{in} = 400 mW

f GHz	Z _{in} Ohms	Z _{OL} * Ohms
1.7	9.5 + j21	6.5 - j8.5
2.0	35 + j20	4.0 - j5.0
2.3	41 + j3.5	7.0 + j1.5

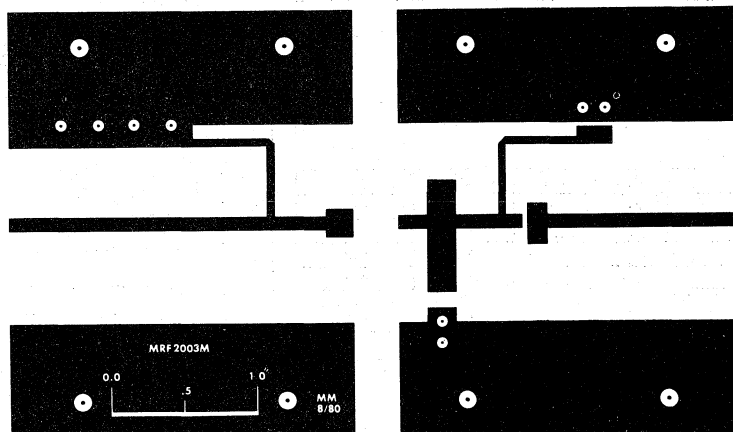
*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — 2 GHz TEST AMPLIFIER



2

FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2.0 GHz TEST CIRCUIT



- ⊙ Denotes Eyelet
- ⊙ Denotes 4-40 Screw Placement

NOTE: The Printed Circuit Board shown is 75% of the original.

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- Guaranteed Performance @ 2 GHz, 28 Vdc
Output Power = 5.0 Watts
Minimum Gain = 8.0 dB
- 100% Tested for Load Mismatch at All Phase Angles
With 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Older 2005 Types
- Other Devices in the 2000 Series:
MRF2001 1 W
MRF2003 3 W
MRF2010 10 W

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	20	Vdc
Collector-Base Voltage	V_{CB0}	45	Vdc
Emitter-Base Voltage	V_{EB0}	3.5	Vdc
Collector-Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	25 140	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	7.0	$^\circ\text{C}/\text{W}$

- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF2005 MRF2005B

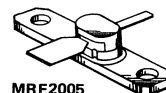
5.0 W 2 GHz

MICROWAVE POWER TRANSISTORS

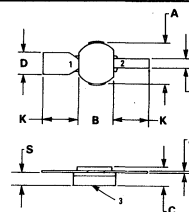
NPN SILICON



MRF2005B



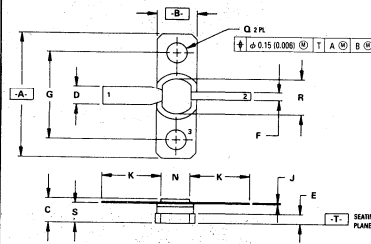
MRF2005



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.72	5.97	0.225	0.235
B	4.44	4.70	0.175	0.185
C	2.29	2.74	0.090	0.108
D	2.92	3.18	0.115	0.125
F	1.14	1.40	0.045	0.055
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
S	1.52	1.78	0.060	0.070

STYLE 1:
PIN 1: EMITTER
2: COLLECTOR
3: BASE

CASE 328-02



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.20	20.57	0.795	0.810
B	6.23	6.47	0.245	0.255
C	3.69	4.31	0.145	0.170
D	2.93	3.17	0.115	0.125
E	1.40	1.77	0.055	0.070
F	1.15	1.39	0.045	0.055
G	14.22 BSC	—	0.560 BSC	—
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
N	4.45	4.69	0.175	0.185
Q	3.05	3.42	0.120	0.135
R	5.72	5.97	0.225	0.235
S	2.93	3.65	0.115	0.140

STYLE 1:
PIN 1: EMITTER
2: COLLECTOR
3: BASE

CASE 328A-02

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
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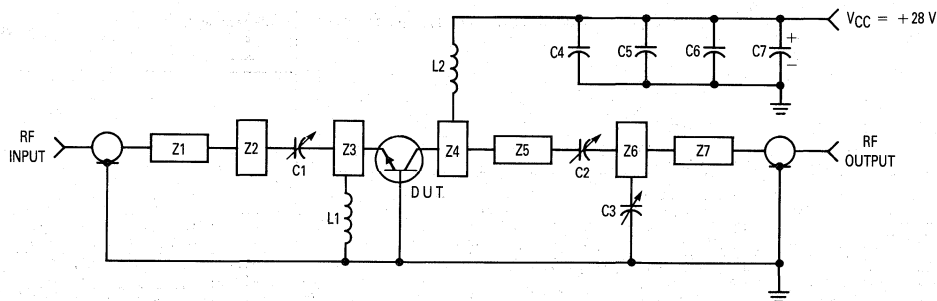
DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	7.5	10	pF
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FUNCTIONAL TESTS

Common-Base Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 2.0\text{ GHz}$)	G_{PB}	8.0	9.0	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 2.0\text{ GHz}$)	η	30	35	—	
Load Mismatch ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 2.0\text{ GHz}$, $VSWR = 10:1$ All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2 GHz TEST CIRCUIT



Z1-Z7 — Microstrip
 C1, C2, C3 — 0.6-4.5 pF Johanson
 C4, C5 — 220 pF Chip Capacitor
 C6 — 0.1 μF
 C7 — 10 μF , 35 V Electrolytic
 L1 — 3 Turns #22 $\frac{1}{8}$ " I.D.
 L2 — 2 Turns #24 $\frac{1}{2}$ " I.D.
 Board Material — 0.062" Glass Teflon

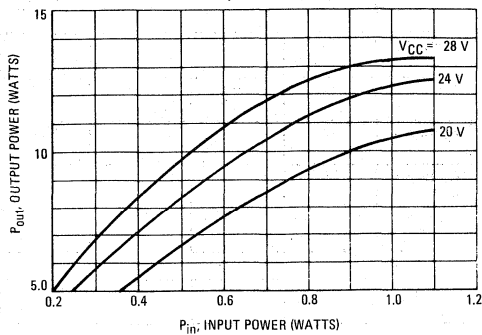
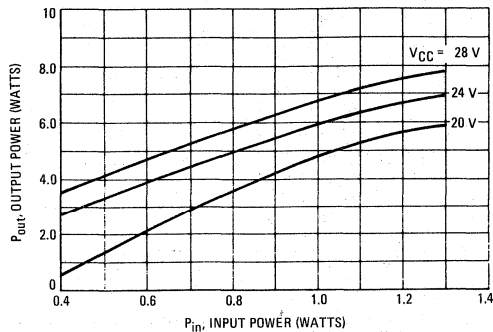
FIGURE 2 — OUTPUT POWER versus INPUT POWER
($f = 1$ GHz)FIGURE 3 — OUTPUT POWER versus INPUT POWER
($f = 2$ GHz)

FIGURE 4 — OUTPUT POWER versus FREQUENCY

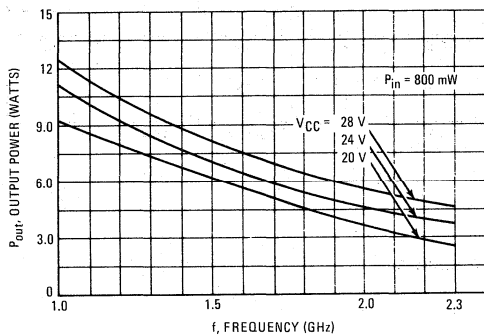


FIGURE 5 — POWER GAIN versus FREQUENCY

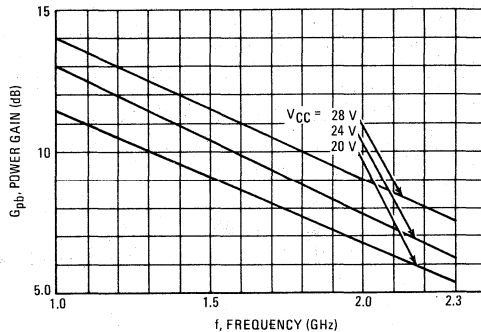
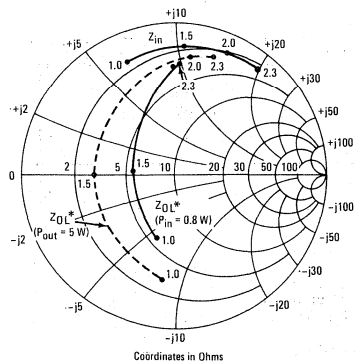


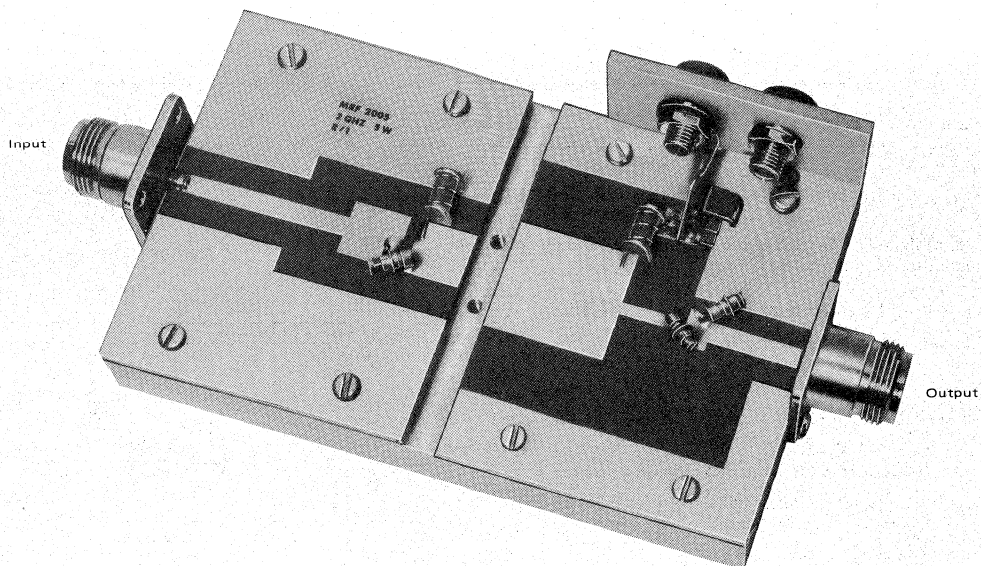
FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



V _{CC} = 28 V					
f GHz	Z _{in} Ohms	Z _{OL} * Ohms	P _{in} = 0.8 W	Z _{OL} * Ohms	P _{out} = 5 W
1.0	1.5 + j5.7	6.3 - j5.6		3.2 - j8.8	
1.5	1.5 + j10.5	5.6 + j0.4		3.0 + j0	
2.0	2.0 + j17	2.5 + j9.0		2.3 + j10.6	
2.3	2.2 + j19.5	2.4 + j9.8		2.4 + j14.5	

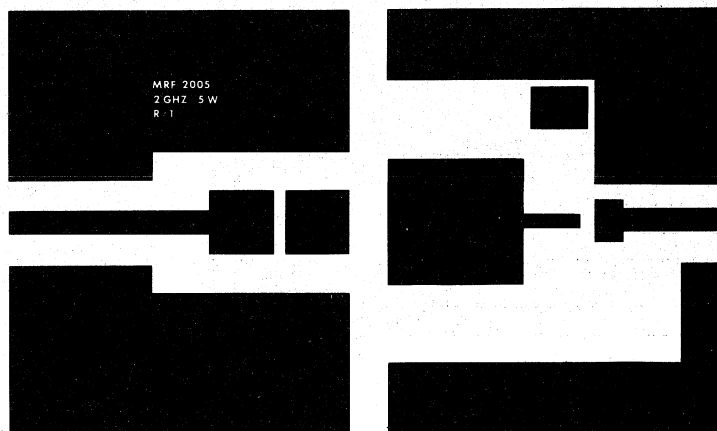
*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 – 2 GHz TEST AMPLIFIER



2

FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 2 GHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF2005M

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

... designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
Output power = 5.0 Watts
Minimum Gain = 7.5 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	20	Vdc
Collector-Base Voltage	V _{CB0}	45	Vdc
Emitter-Base Voltage	V _{EBO}	3.5	Vdc
Collector-Current — Continuous	I _C	1.0	Adc
Total Device Dissipation @ T _C = 25°C (1) Derate above 25°C	P _D	22 130	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

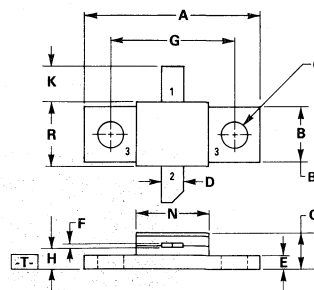
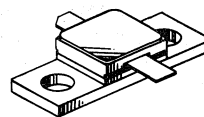
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	R _{θJC}	8.0	°C/W

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

5.0 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

- NOTES:
1. DIMENSIONS [A] AND [B] ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
Ⓢ 0.13 (0.005) Ⓢ T A Ⓢ B Ⓢ
3. [T] IS SEATING PLANE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.48	6.73	0.255	0.265
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
F	0.05	0.15	0.002	0.006
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 300\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 24\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	7.5	10	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 2.0\text{ GHz}$)	G_{PB}	7.5	8.0	—	dB
Collector Efficiency ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 2.0\text{ GHz}$)	η	35	40	—	%
Load Mismatch ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 2.0\text{ GHz}$) VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

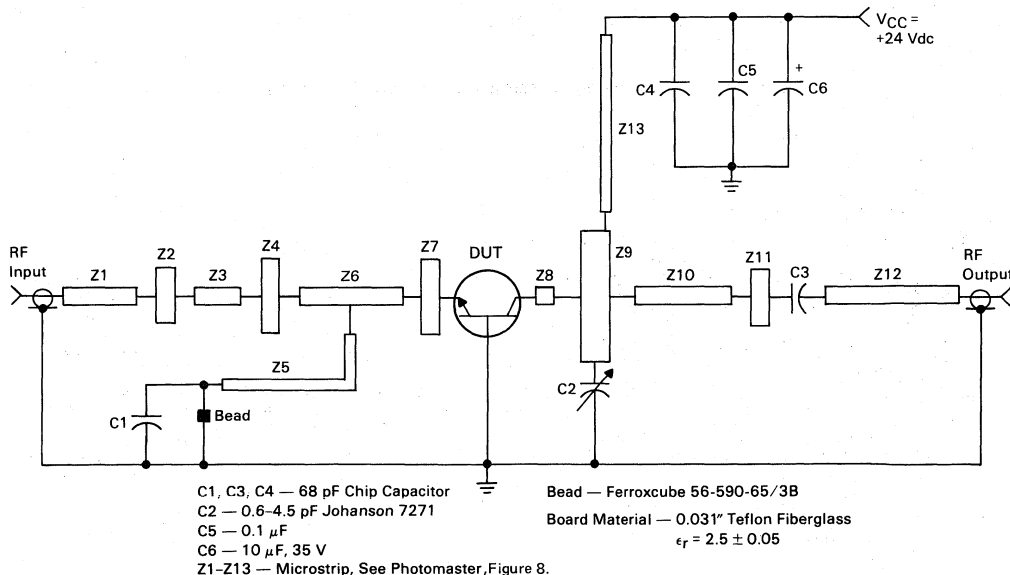
FIGURE 1 — 2.0 GHz TEST CIRCUIT

FIGURE 2 — OUTPUT POWER versus INPUT POWER
(f = 1.7 GHz)

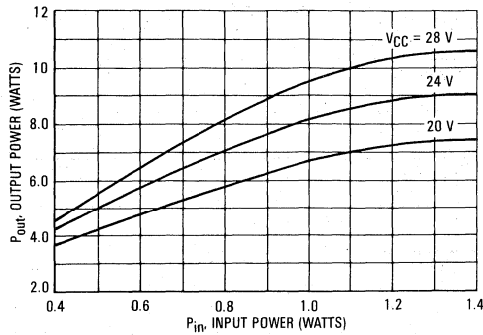


FIGURE 3 — OUTPUT POWER versus INPUT POWER
(f = 2.0 GHz)

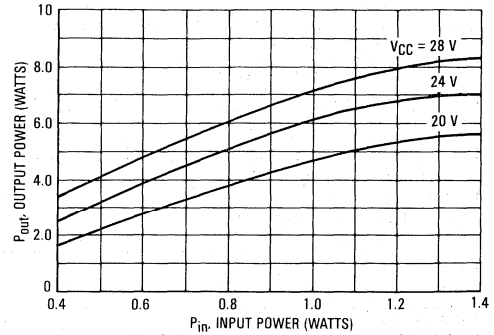


FIGURE 4 — OUTPUT POWER versus INPUT POWER
(f = 2.3 GHz)

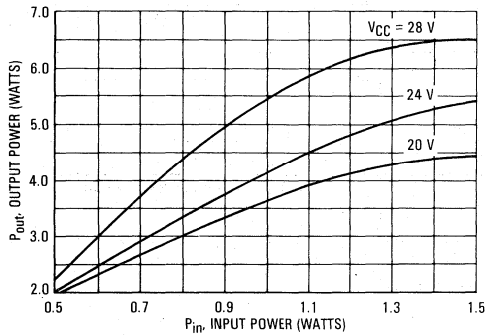


FIGURE 5 — POWER GAIN versus FREQUENCY

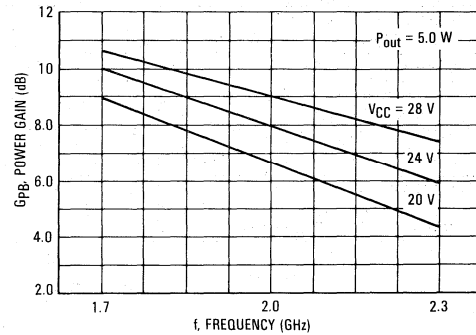
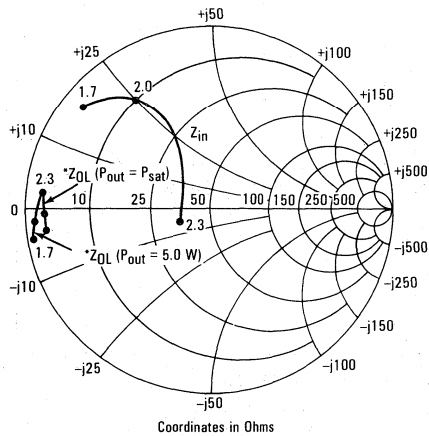


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

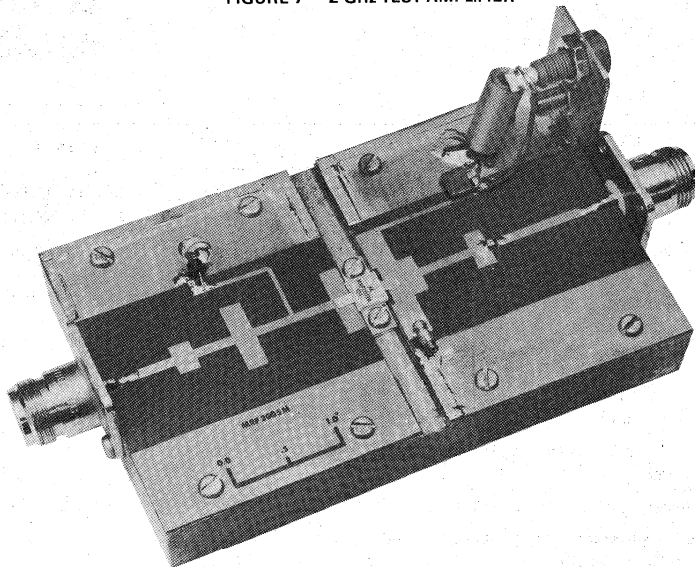


V_{CC} = 24 V

f GHz	Z _{in} Ohms	Z _{OL} [*] , Ohms P _{out} = P _{sat}	Z _{OL} [*] , Ohms P _{out} = 5.0 W
1.7	4.0 + j17	2.9 - j3.5	1.5 - j4.4
2.0	10 + j25	3.1 - j0.85	1.75 - j1.3
2.3	37 - j5.0	2.9 + j2.2	2.90 + j2.2

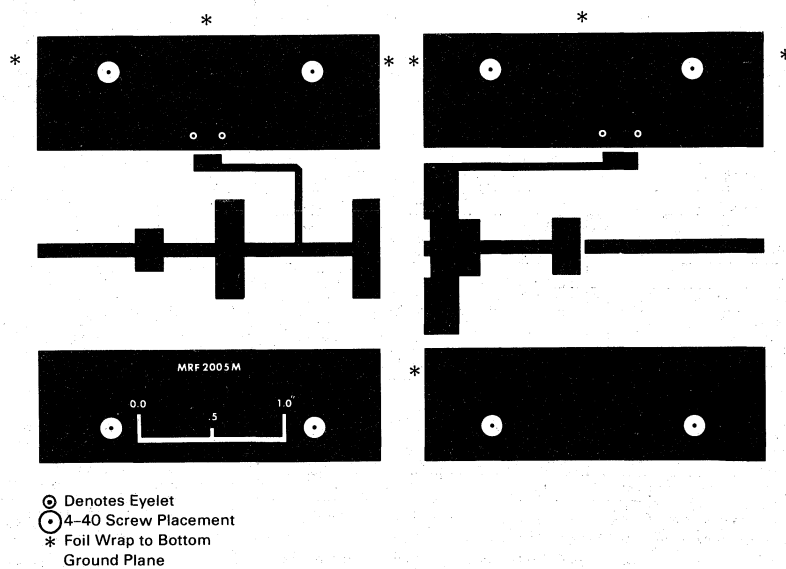
*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 — 2 GHz TEST AMPLIFIER



2

FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2.0 GHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTORS

... designed for Class B and C amplifier or oscillator applications in the 1.0 to 2.3 GHz frequency range.

- Guaranteed Performance @ 2 GHz, 28 Vdc
Output Power = 10 Watts
Minimum Gain = 6.0 dB
- 100% Tested for Load Mismatch at All Phase Angles
With 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and
Resistance to Metal Migration
- Compatible with Older 2010 Types
- Other Devices in the 2000 Series:
MRF2001 1 W
MRF2003 3 W
MRF2005 5 W

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	35 200	Watts $\text{mW}/^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.0	$^\circ\text{C}/\text{W}$

- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
- (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF2010 MRF2010B

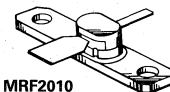
10 W 2 GHz

MICROWAVE POWER TRANSISTORS

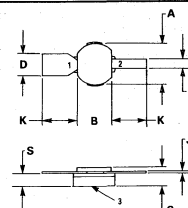
NPN SILICON



MRF2010B



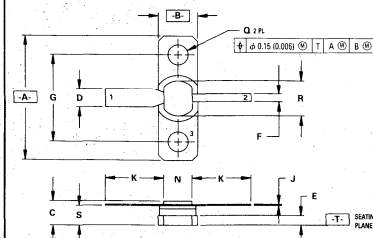
MRF2010



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.72	5.97	0.225	0.235
B	4.44	4.70	0.175	0.185
C	2.29	2.74	0.090	0.108
D	2.92	3.18	0.115	0.125
F	1.14	1.40	0.045	0.055
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
S	1.52	1.78	0.060	0.070

STYLE 1:
PIN 1: EMITTER
2: COLLECTOR
3: BASE

CASE 328-02



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.20	20.57	0.795	0.810
B	6.23	6.47	0.245	0.255
C	3.69	4.21	0.145	0.170
D	2.93	3.17	0.115	0.125
E	1.40	1.77	0.055	0.070
F	1.15	1.39	0.045	0.055
G	14.22 BSC	—	0.560 BSC	—
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
N	4.45	4.69	0.175	0.185
O	3.05	3.42	0.120	0.135
R	5.72	5.97	0.225	0.235
S	2.93	3.55	0.115	0.140

STYLE 1:
PIN 1: EMITTER
2: COLLECTOR
3: BASE

CASE 328A-02

ELECTRICAL CHARACTERISTICS ($T_C = 25^{\circ}\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mAdc}$, $R_{BE} = 10 \Omega$)	$V_{(BR)CER}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20 \text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.0 \text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28 \text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	2.0	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500 \text{ mA}$, $V_{CE} = 5.0 \text{ V}$)	h_{FE}	10	—	100	—
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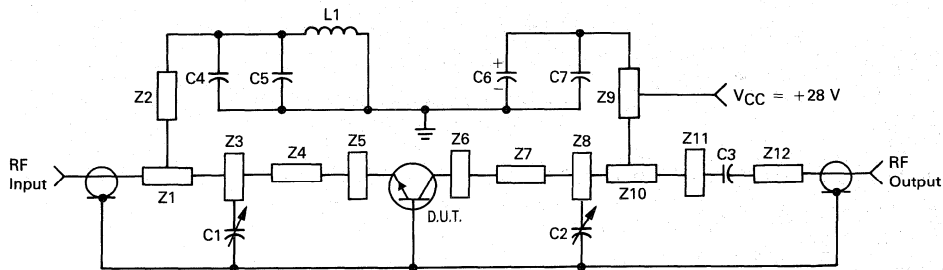
DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	C_{ob}	—	12	15	pF
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FUNCTIONAL TESTS

Common-Base Amplifier Power Gain ($V_{CC} = 28 \text{ Vdc}$, $P_{out} = 10 \text{ W}$, $f = 2.0 \text{ GHz}$)	G_{PB}	6.0	7.0	—	dB
Collector Efficiency ($V_{CC} = 28 \text{ Vdc}$, $P_{out} = 10 \text{ W}$, $f = 2.0 \text{ GHz}$)	η	30	35		
Load Mismatch ($V_{CC} = 28 \text{ Vdc}$, $P_{out} = 10 \text{ W}$, $f = 2.0 \text{ GHz}$, $V_{SWR} = 10:1$ All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 – 2 GHz TEST CIRCUIT



Z1-Z12 — Microstrip
C1, C2 — 0.4–2.5 pF Johanson
C3, C4, C5, C7 — 39 pF Chip Capacitor
C6 — 20 μ F, 50 V Electrolytic
L1 — #18 AWG Hairpin



1/8" 1/8"

Board Material — 0.032" Glass Teflon

FIGURE 2 — OUTPUT POWER versus INPUT POWER
(f = 1.0 GHz)

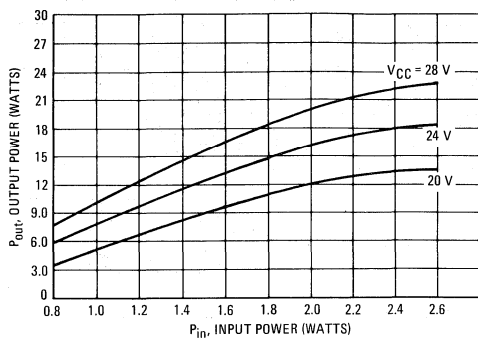


FIGURE 3 — OUTPUT POWER versus INPUT POWER
(f = 2.0 GHz)

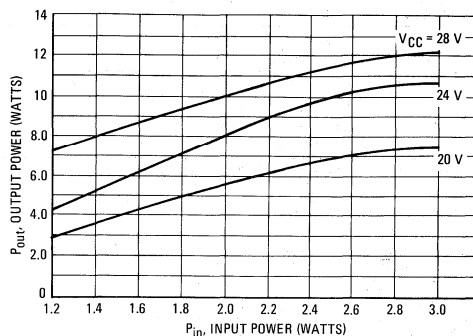


FIGURE 4 — OUTPUT POWER versus FREQUENCY

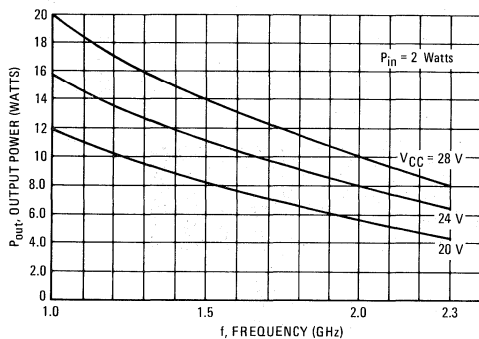


FIGURE 5 — POWER GAIN versus FREQUENCY

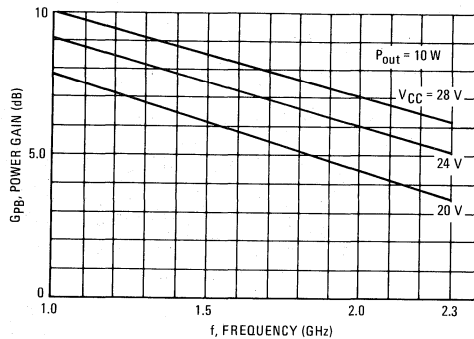
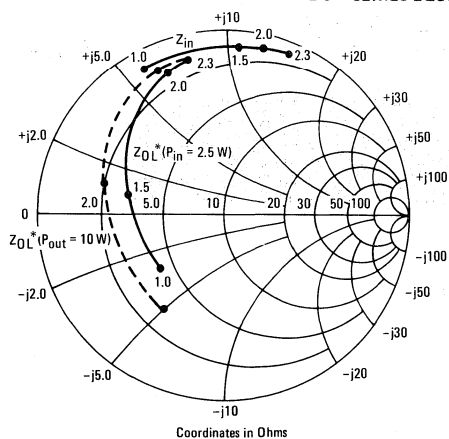


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

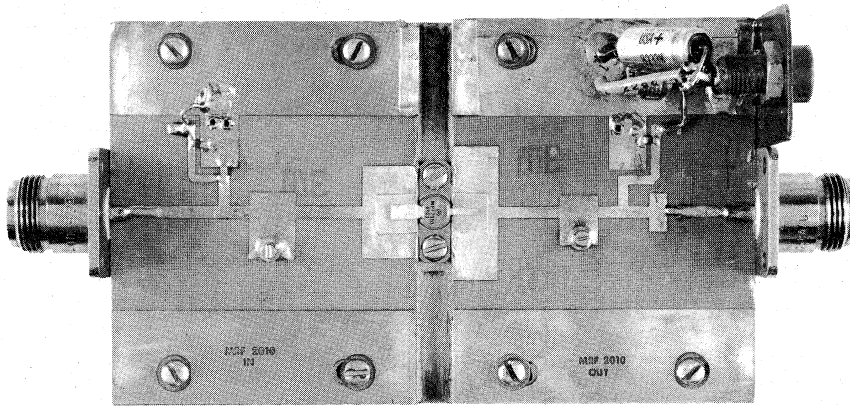


$V_{CC} = 28 \text{ V}$

f GHz	Z_{in} Ohms	Z_{OL}^* $P_{in} = 2.5 \text{ W}$ Ohms	Z_{OL}^* $P_{out} = 10 \text{ W}$ Ohms
1.0	$1.0 + j6.0$	$4.5 - j3.0$	$3.2 - j5.0$
1.5	$1.0 + j11$	$3.5 + j1.0$	$2.0 + j1.3$
2.0	$1.5 + j13$	$1.5 + j7.0$	$1.4 + j6.5$
2.3	$1.5 + j16$	$1.3 + j8.0$	$1.3 + j8.0$

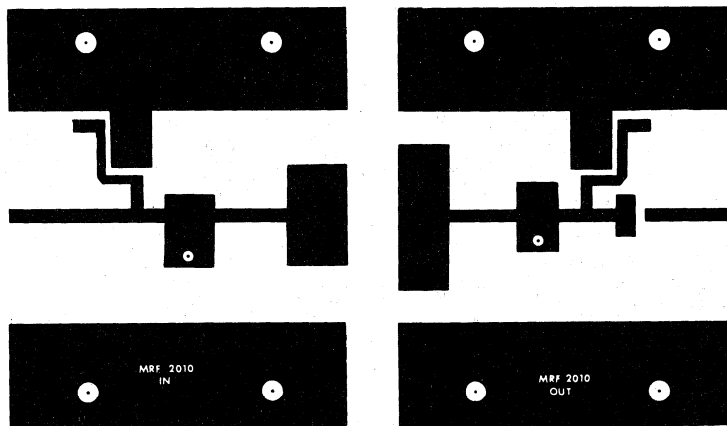
* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 – 2 GHz TEST AMPLIFIER



2

FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 2 GHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line

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... designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
Output Power = 10 Watts
Minimum Gain = 7.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE0}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	35 200	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

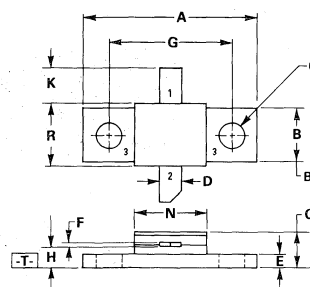
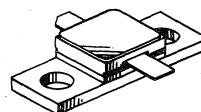
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.0	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

MRF2010M

10 W 2 GHz MICROWAVE POWER TRANSISTOR

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

- NOTES:
1. DIMENSIONS [A] AND [B] ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
[+0.13 (0.005) T A B]
3. [-T] IS SEATING PLANE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

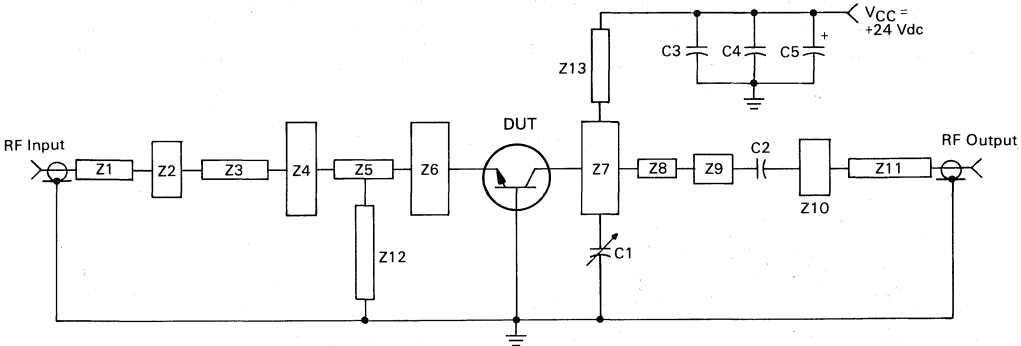
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.48	6.73	0.255	0.265
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
F	0.05	0.15	0.002	0.006
G	14.27 BSC		0.560 BSC	
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 20 mAdc, I _B = 0)	V _{(BR)CEO}	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I _C = 20 mAdc, V _{BE} = 0)	V _{(BR)CES}	45	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 20 mAdc, I _E = 0)	V _{(BR)CBO}	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 2.0 mAdc, I _C = 0)	V _{(BR)EBO}	3.5	—	—	Vdc
Collector Cutoff Current (V _{CB} = 28 Vdc, I _E = 0)	I _{CBO}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I _C = 500 mAdc, V _{CE} = 5.0 Vdc)	h _{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V _{CB} = 24 Vdc, I _E = 0, f = 1.0 MHz)	C _{ob}	—	14	18	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V _{CC} = 24 Vdc, P _{out} = 10 W, f = 2.0 GHz)	G _{pb}	7.0	8.0	—	dB
Collector Efficiency (V _{CC} = 24 Vdc, P _{out} = 10 W, f = 2.0 GHz)	η	35	40		
Load Mismatch (V _{CC} = 24 Vdc, P _{out} = 10 W, f = 2.0 GHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2 GHz TEST CIRCUIT



Z1-Z13 — Microstrip. See Photomaster, Figure 8.
C2, C3 — 68 pF Chip Capacitor
C4 — 0.1 μF
C5 — 10 μF, 35 V
C1 — 0.6-4.5 pF Johanson 7271
Board Material — 0.0312" Teflon Fiberglass
ε_r = 2.5 ± 0.05

FIGURE 2 — OUTPUT POWER versus INPUT POWER
($f = 1.7$ GHz)

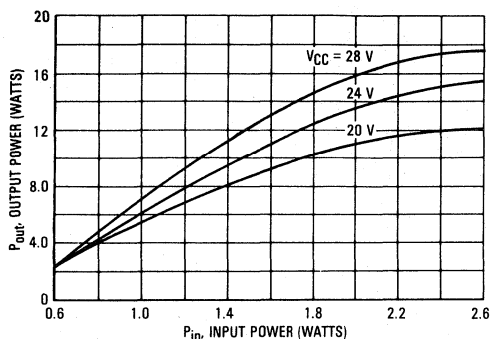


FIGURE 3 — OUTPUT POWER versus INPUT POWER
($f = 2.0$ GHz)

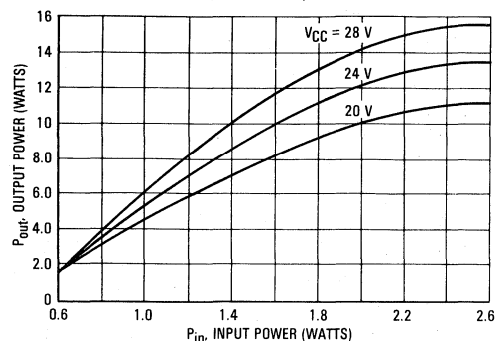


FIGURE 4 — OUTPUT POWER versus INPUT POWER
($f = 2.3$ GHz)

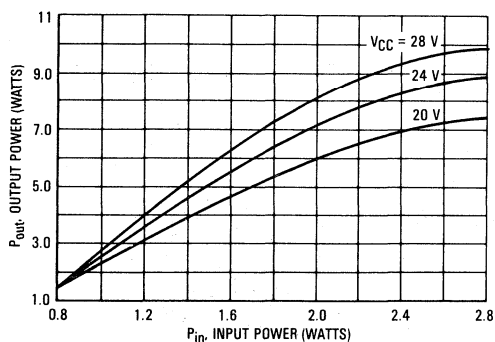


FIGURE 5 — POWER GAIN versus FREQUENCY

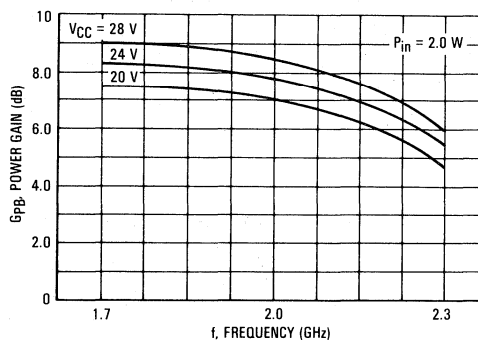
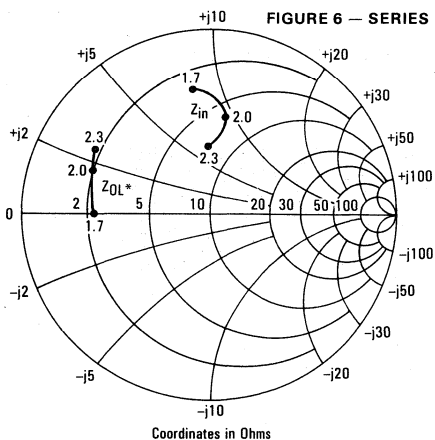


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



$V_{CC} = 24$ V, $P_{in} = 2.0$ W

f GHz	Z_{in} Ohms	Z_{out}^* Ohms
1.7	$3.5 + j8.0$	$2.3 + j0$
2.0	$7.0 + j9.5$	$2.0 + j1.6$
2.3	$8.0 + j6.5$	$1.8 + j2.2$

* Z_{out} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 — 2 GHz TEST AMPLIFIER

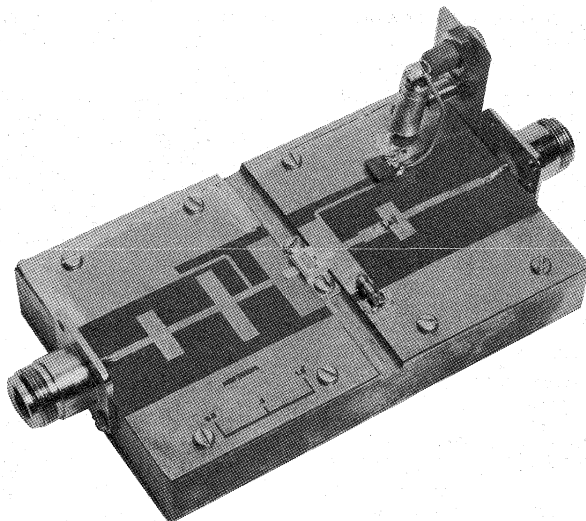
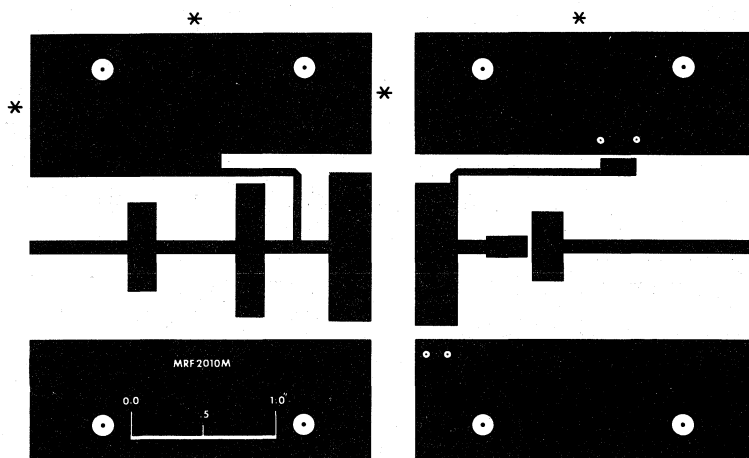


FIGURE 8 — 2 GHz TEST CIRCUIT PHOTOMASTER



- ⊙ Denotes Eyelet
- ⊗ Denotes 4-40 Screw Placement
- * Foil Wrap to Bottom Ground Plane

NOTE: The Printed Circuit Board shown is 75% of the original.

MRF2016M

The RF Line

NPN SILICON MICROWAVE POWER TRANSISTOR

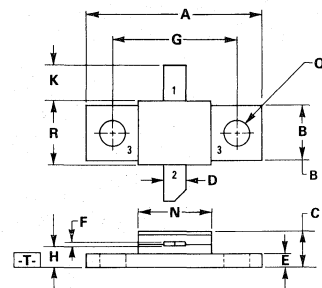
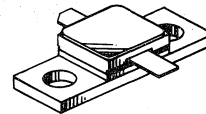
... designed for Class B and C *common base* broadband amplifier applications in the 1.7 to 2.3 GHz frequency range.

- Internal Input Matching for Broadband Operation
- Guaranteed Performance @ 2 GHz, 24 Vdc
Output power = 16 Watts
Minimum Gain = 6.5 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivation
- Characterized for Operation from 20 V to 28 V Supply Voltages

16 W 2 GHz

MICROWAVE POWER TRANSISTOR

NPN SILICON



STYLE 1:
 PIN 1. EMITTER
 2. COLLECTOR
 3. BASE

- NOTES:
1. DIMENSIONS [A] AND [B] ARE DATUMS.
 2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
 ± 0.13 (0.005) M T A M B M
 3. [F] IS SEATING PLANE.
 4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.48	6.73	0.255	0.265
C	3.68	4.06	0.145	0.160
D	2.29	2.79	0.090	0.110
E	1.42	1.73	0.056	0.068
F	0.05	0.15	0.002	0.006
G	14.27	BSC	0.560	BSC
H	2.29	2.79	0.090	0.110
K	3.43	4.19	0.135	0.165
N	7.87	8.38	0.310	0.330
Q	3.05	3.30	0.120	0.130
R	7.24	7.49	0.285	0.295

CASE 337-02

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	3.0	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	50 286	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	3.5	$^\circ\text{C}/\text{W}$

- (1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
 (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 30\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	3.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 24\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	20	25	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 16\text{ W}$, $f = 2.0\text{ GHz}$)	G_{PB}	6.5	7.0	—	dB
Collector Efficiency ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 16\text{ W}$, $f = 2.0\text{ GHz}$)	η	35	40	—	%
Load Mismatch ($V_{CC} = 24\text{ Vdc}$, $P_{out} = 16\text{ W}$, $f = 2.0\text{ GHz}$, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 2 GHz TEST CIRCUIT

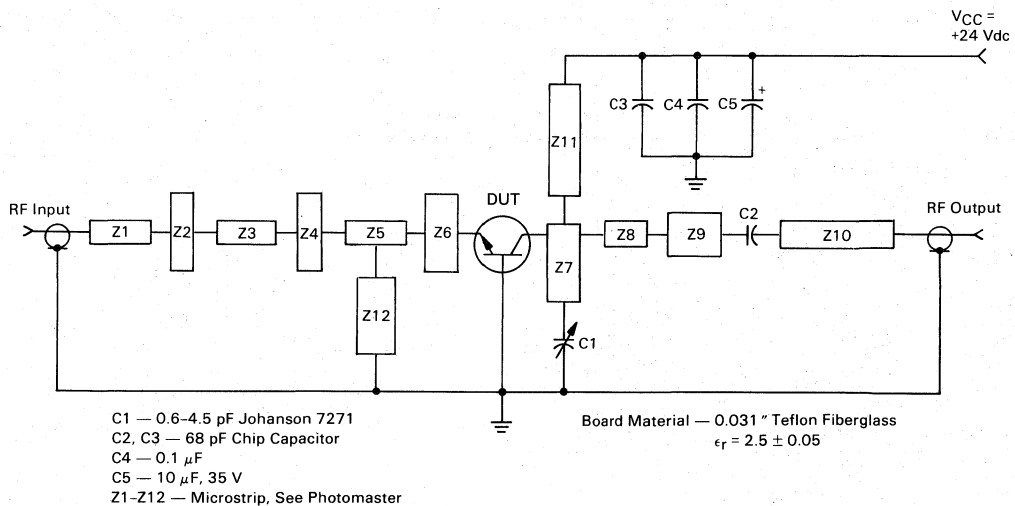


FIGURE 2 — OUTPUT POWER versus INPUT POWER
($f = 1.7$ GHz)

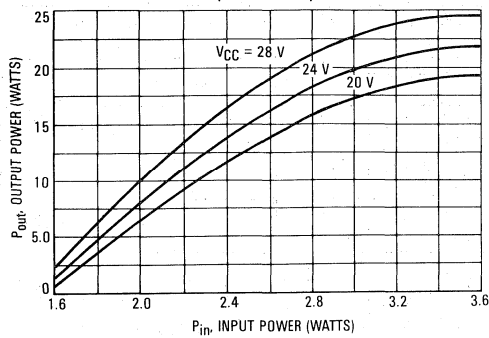


FIGURE 3 — OUTPUT POWER versus INPUT POWER
($f = 2.0$ GHz)

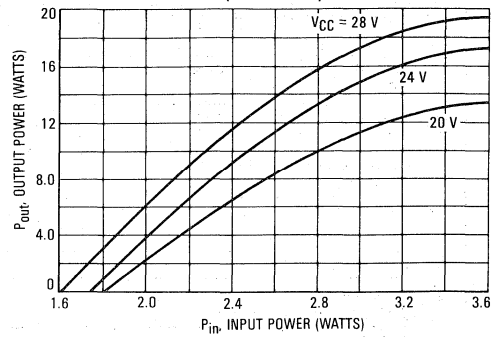


FIGURE 4 — OUTPUT POWER versus INPUT POWER
($f = 2.3$ GHz)

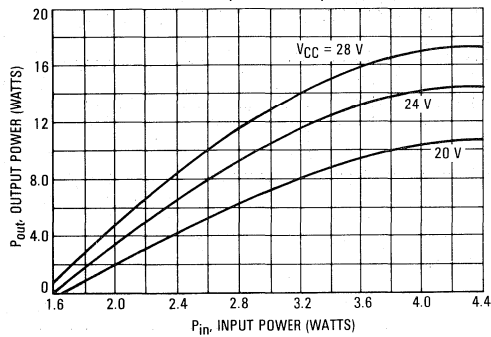


FIGURE 5 — POWER GAIN versus FREQUENCY

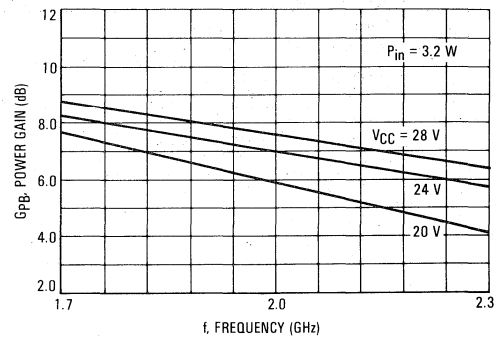
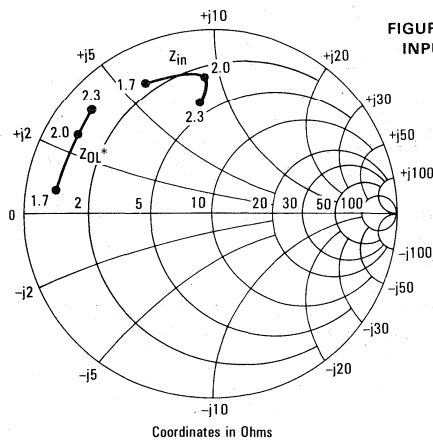


FIGURE 6 — SERIES EQUIVALENT
INPUT/OUTPUT IMPEDANCE

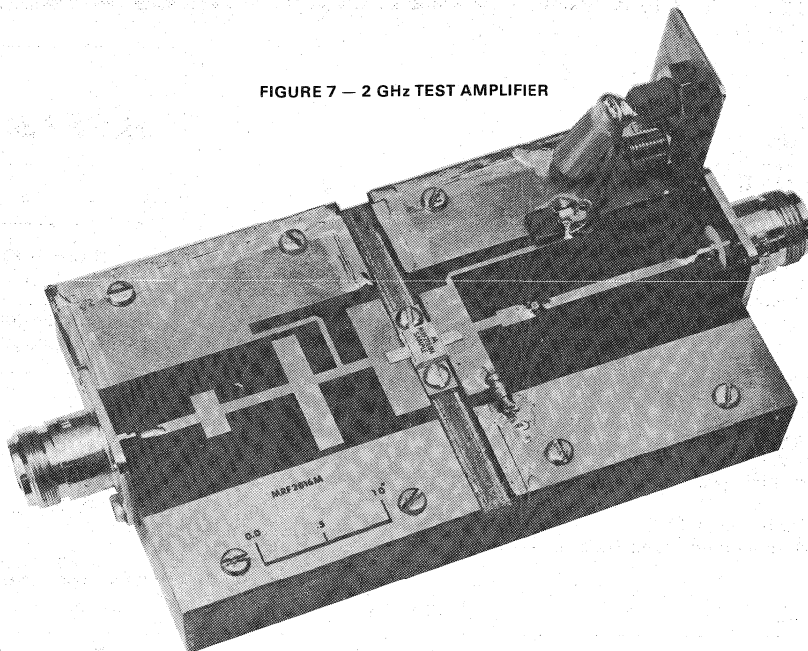


$V_{CC} = 24$ V, $P_{in} = 3.2$ W

f GHz	Z_{in} Ohms	Z_{OL}^* Ohms
1.7	$1.8 + j6.1$	$1.2 + j1.0$
2.0	$2.4 + j9.2$	$1.0 + j2.6$
2.3	$4.4 + j8.3$	$1.0 + j3.5$

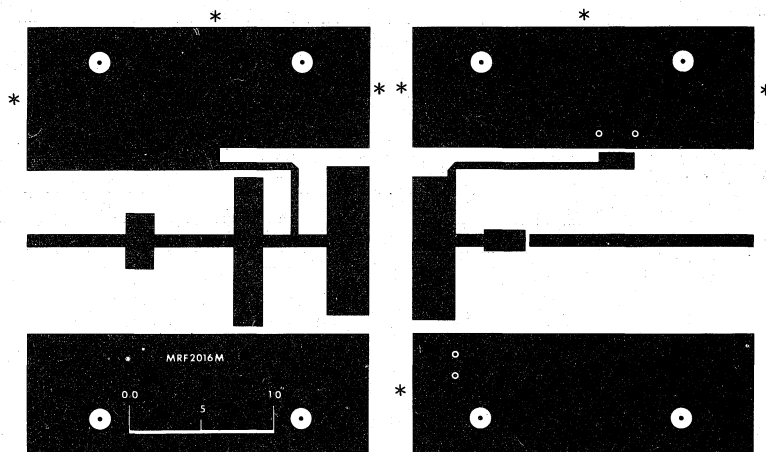
* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — 2 GHz TEST AMPLIFIER



2

FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 2 GHz TEST CIRCUIT



- ⊙ Denotes Eyelet
- ⊗ 4-40 Screw Placement
- * Foil Wrap to Bottom Ground Plane

NOTE: The Printed Circuit Board shown is 75% of the original.

The RF Line NPN Silicon High Frequency Transistor

... designed for low-noise, wide dynamic range front end amplifiers, low-noise VCO's and microwave power multipliers.

- Low Noise
- High Gain
- Available in Low Cost Plastic
- State-of-the-Art Technology
 - Fine Line Geometry
 - Ion Implanted Arsenic Emitters
 - Gold Top Metallization and Wires
 - Silicon Nitride Passivation
- Fully Characterized
- Higher Voltage Version of MRF571
- Internally Ballasted for Improved Ruggedness

MRF2369

$f_T = 6 \text{ GHz @ } 50 \text{ mA}$
 $NF = 1.5 \text{ dB @ } 1 \text{ GHz}$
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



MACRO-X
CASE 317-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous.	I_C	70	mA _{dc}
Total Device Dissipation ($\text{at } T_C = 50^\circ\text{C (1)}$ Derate above 50°C)	P_D	0.75 7.5	Watt mW/ $^\circ\text{C}$
Storage Temperature	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	133	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mAdc}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 50\text{ }\mu\text{Adc}$, $I_C = 0$)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	10	μAdc

ON CHARACTERISTICS

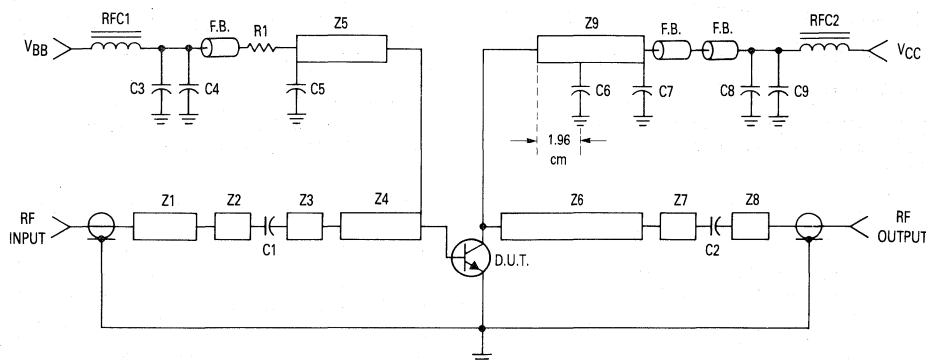
DC Current Gain ($I_C = 30\text{ mAdc}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	50	—	300	—
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DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{cb}	—	0.7	1	pF
Current Gain — Bandwidth Product ($V_{CE} = 10\text{ Vdc}$, $I_C = 40\text{ mA}$, $f = 1\text{ GHz}$)	f_T	—	6	—	GHz

FUNCTIONAL TESTS

Gain @ Noise Figure ($I_C = 5\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	$f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$	G_{NF}	— 10	16.5 12	— —	dB
Noise Figure ($I_C = 5\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$)	$f = 0.5\text{ GHz}$ $f = 1\text{ GHz}$ $f = 2\text{ GHz}$	NF	— — —	1 1.5 2.8	— 2 —	dB



C1, C2, C6 560 pF Chip Capacitor
C5, C7 0.018 μF Chip Capacitor
C3, C8 0.1 μF Mylar Capacitor
C4, C9 1 μF Electrolytic Capacitor
R1 2.7 k Ω

RFC1, RFC2 VK-200, Ferroxcube
Z1–Z9 Microstrip, See Photomaster
Bead Ferrite Bead, Ferroxcube 56-590-65/3B
Board Material 0.0625" Teflon Fiberglass $\epsilon_r = 2.5 \pm 0.05$

Figure 1. 1 GHz Test Circuit

TYPICAL CHARACTERISTICS

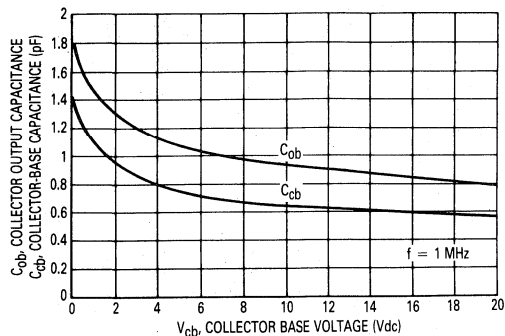


Figure 2. C_{cb} , Collector-Base Capacitance versus Voltage

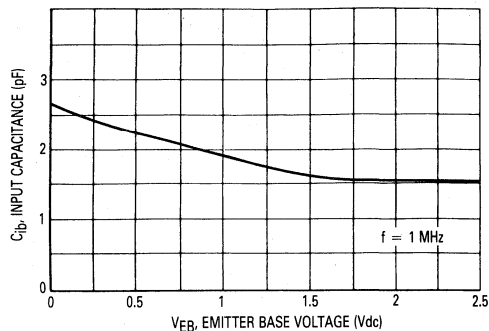


Figure 3. C_{ib} , Input Capacitance versus Emitter Base Voltage

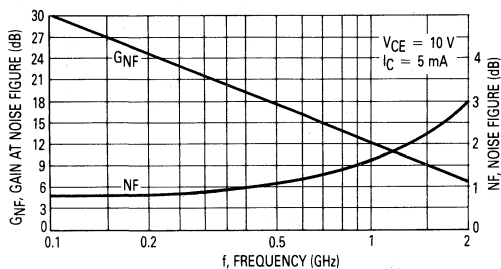


Figure 4. Gain at Noise Figure and Noise Figure versus Frequency

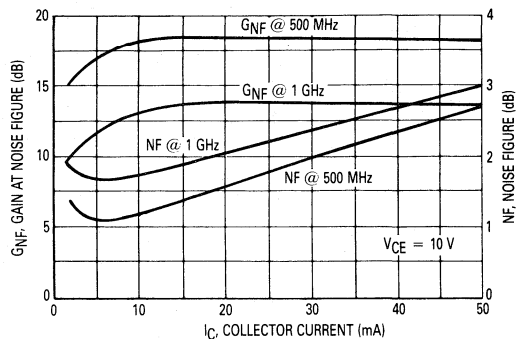


Figure 5. Gain at Noise Figure and Noise Figure versus Collector Current

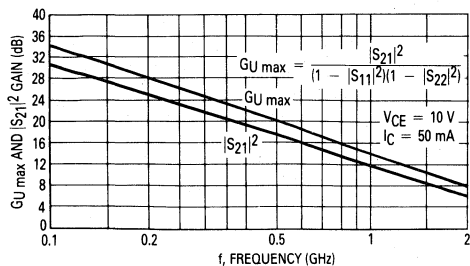


Figure 6. GU_{max} and $|S_{21}|^2$ versus Frequency

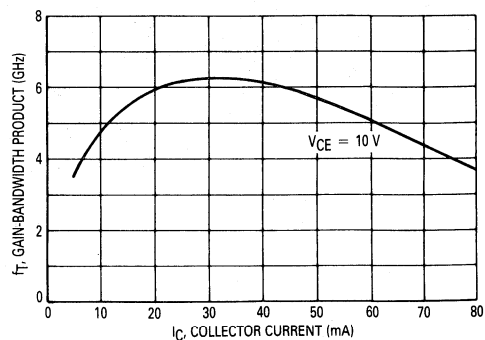
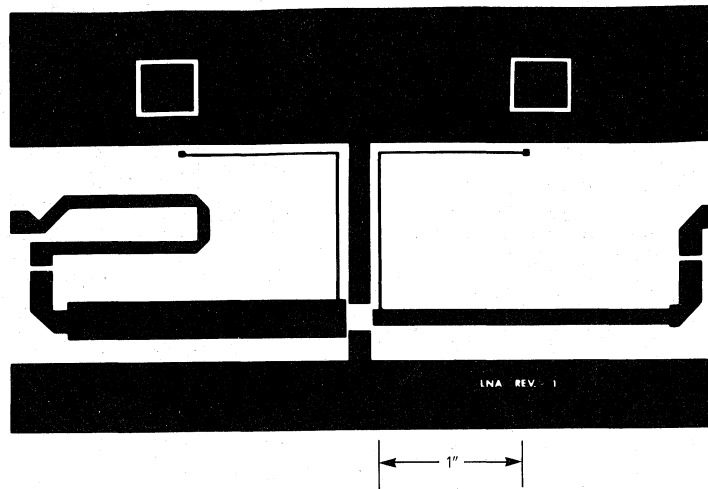


Figure 7. Gain-Bandwidth Product versus Collector Current

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
5	5	100	0.83	-45	14.1	152	0.03	69	0.88	-24
		200	0.70	-81	10.5	130	0.06	51	0.74	-37
		500	0.63	-140	5.7	98	0.08	35	0.47	-57
		1000	0.59	175	3	72	0.10	38	0.36	-68
		1500	0.57	150	2	56	0.12	45	0.35	-85
		2000	0.56	128	1.5	43	0.15	50	0.37	-96
	10	100	0.72	-63	21.2	142	0.03	61	0.83	-33
		200	0.63	-103	14.4	122	0.05	49	0.60	-51
		500	0.59	-156	7	93	0.07	42	0.35	-69
		1000	0.56	166	3.6	71	0.09	50	0.24	-79
		1500	0.55	143	2.4	57	0.12	55	0.24	-95
		2000	0.53	123	1.8	45	0.16	55	0.26	-101
	25	100	0.54	-93	29.1	132	0.02	63	0.68	-47
		200	0.57	-132	17.9	111	0.03	50	0.45	-66
		500	0.57	-173	7.9	88	0.05	53	0.23	-83
		1000	0.55	157	3.9	70	0.09	62	0.15	-93
		1500	0.54	137	2.6	57	0.13	62	0.16	-109
		2000	0.52	118	2	46	0.18	59	0.18	-109
	50	100	0.51	-118	31.6	126	0.02	63	0.58	-52
		200	0.57	-150	17.9	106	0.03	50	0.36	-66
		500	0.59	178	7.6	85	0.05	61	0.19	-76
		1000	0.58	153	3.7	68	0.09	67	0.15	-82
		1500	0.57	135	2.5	55	0.13	67	0.16	-100
		2000	0.55	116	1.9	44	0.17	63	0.19	-103
10	5	100	0.87	-39	14	155	0.03	70	0.89	-22
		200	0.75	-74	10.8	133	0.05	55	0.78	-32
		500	0.64	-134	6.1	100	0.08	37	0.53	-47
		1000	0.57	179	3.2	73	0.09	40	0.42	-57
		1500	0.56	153	2.1	56	0.11	47	0.41	-73
		2000	0.54	130	1.6	44	0.13	54	0.44	-83
	10	100	0.76	-57	21.9	145	0.02	70	0.83	-28
		200	0.64	-95	15.1	124	0.04	52	0.64	-43
		500	0.57	-151	7.5	94	0.06	43	0.40	-55
		1000	0.54	169	3.8	72	0.08	52	0.30	-61
		1500	0.53	146	2.5	57	0.11	57	0.30	-76
		2000	0.51	125	1.9	45	0.15	59	0.33	-84
	25	100	0.60	-82	30.4	133	0.02	60	0.73	-40
		200	0.56	-123	19.1	114	0.03	49	0.48	-53
		500	0.54	-168	8.5	89	0.05	54	0.28	-60
		1000	0.52	159	4.3	70	0.08	63	0.21	-64
		1500	0.52	139	2.8	57	0.12	64	0.22	-79
		2000	0.50	120	2.1	46	0.16	63	0.25	-84
	50	100	0.54	-104	33.5	127	0.01	60	0.63	-44
		200	0.55	-141	19.4	107	0.02	51	0.40	-51
		500	0.55	-177	8.3	85	0.04	61	0.26	-52
		1000	0.54	155	4.1	68	0.08	68	0.22	-56
		1500	0.54	137	2.7	55	0.11	69	0.23	-73
		2000	0.52	118	2	45	0.16	66	0.27	-81

Figure 8. Common Emitter S-Parameters



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 9. Photomaster of Circuit Layout

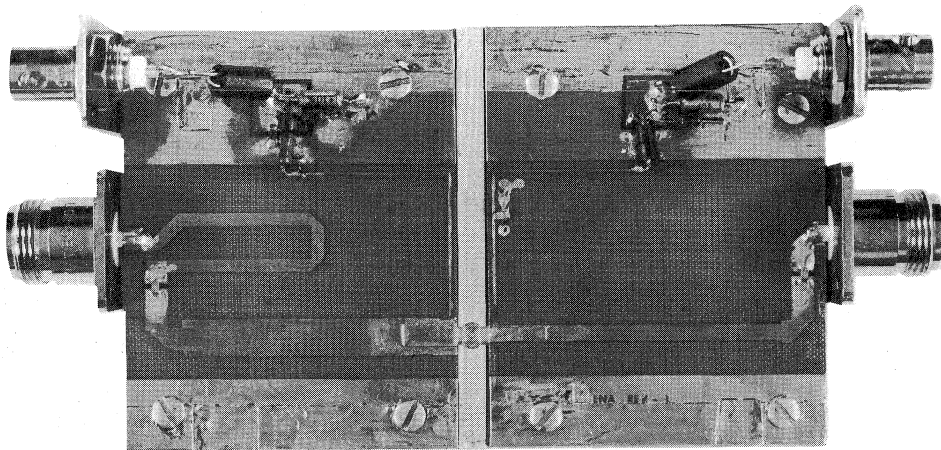


Figure 10. Test Circuit

MRF2628

The RF Line

NPN SILICON RF POWER TRANSISTOR

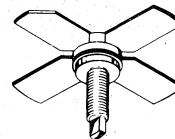
Designed for 12.5 volt VHF large-signal power amplifiers in commercial and industrial FM equipment.

- Compact .280 Stud Package
- Specified 12.5 V, 175 MHz Performance
 - Output Power = 15 Watts
 - Power Gain = 12 dB Min
 - Efficiency = 60% Min
- Characterized to 220 MHz
- Load Mismatch Capability at High Line and Overdrive

15 W 136–220 MHz

RF POWER TRANSISTOR

NPN SILICON

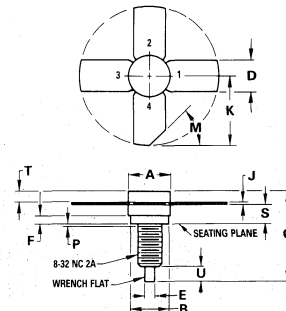


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	40 0.23	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	– 65 to + 150	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	$^\circ\text{C/W}$



STYLE 1:
 PIN 1: EMITTER
 2: BASE
 3: EMITTER
 4: COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45°	NOM	45°	NOM
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	1.0	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	70	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	33	60	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 175\text{ MHz}$)	G_{pe}	12	13	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 15\text{ W}$, $f = 175\text{ MHz}$)	η	60	68	—	%
Load Mismatch ($V_{CC} = 15.5\text{ V}$, $P_{in} = 2.0\text{ dB}$ Overdrive, Load VSWR = 30:1)	ψ	No Degradation in Output Power			

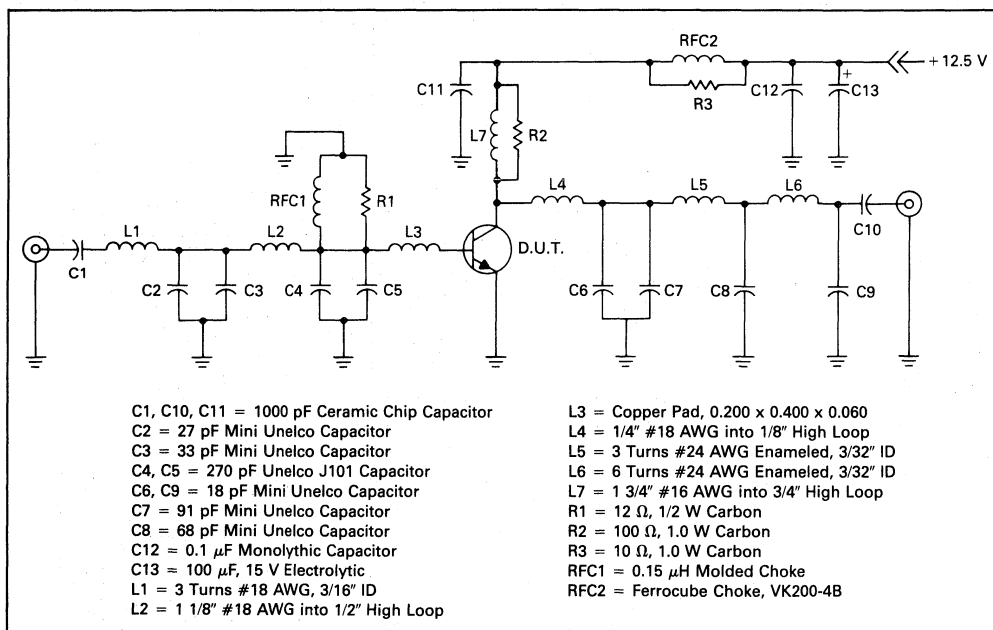
FIGURE 1 — BROADBAND CIRCUIT

FIGURE 2 — OUTPUT POWER versus FREQUENCY

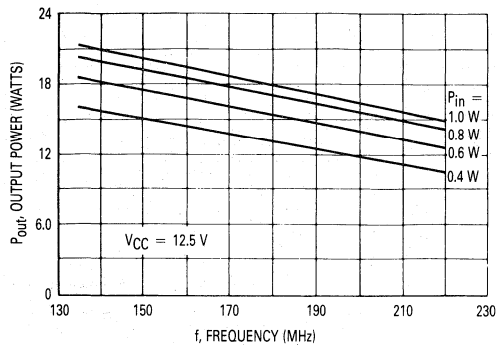


FIGURE 3 — OUTPUT POWER versus INPUT POWER

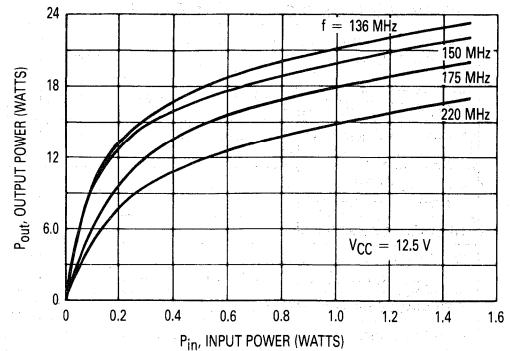
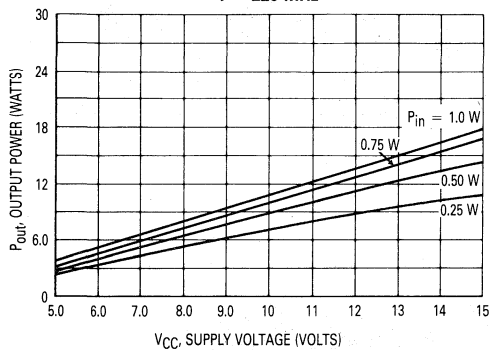
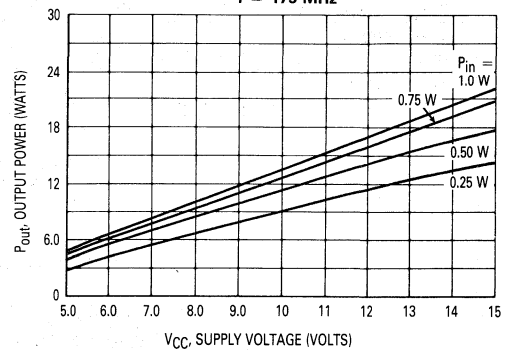
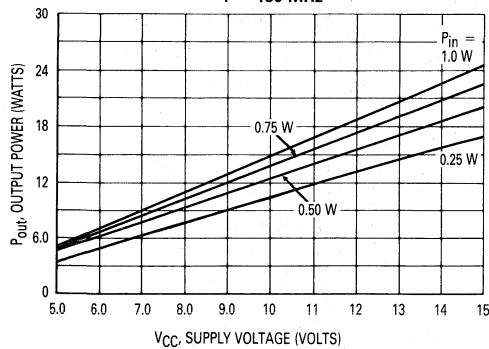
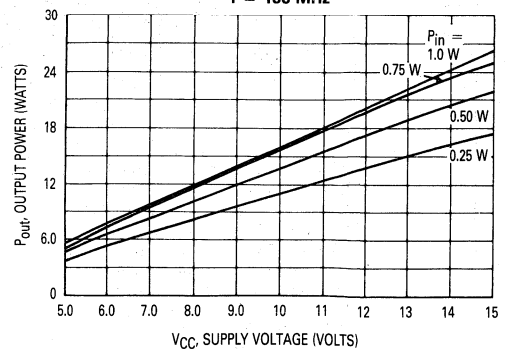
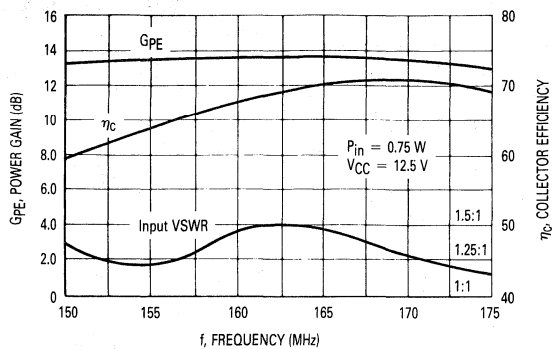
FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 220$ MHzFIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 175$ MHzFIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 150$ MHzFIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
 $f = 136$ MHz

FIGURE 8 — TYPICAL PERFORMANCE IN A BROADBAND CIRCUIT



f MHz	Z _{in} Ohms	Z _{OL} * Ohms
220	0.62 + j0.39	5.25 - j2.46
175	0.69 - j0.17	5.26 - j3.46
150	0.68 - j0.61	5.23 - j4.14
136	0.59 - j0.80	5.07 - j4.76

*Z_{OL} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 9 — SERIES EQUIVALENT IMPEDANCE

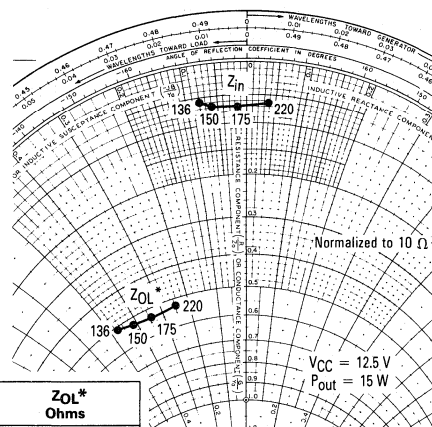
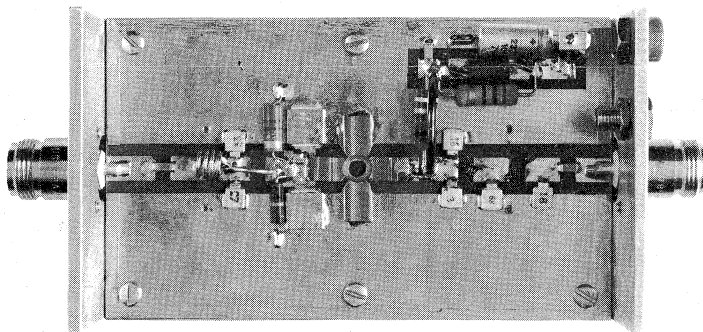


FIGURE 10 — BROADBAND TEST CIRCUIT



The RF Line
NPN Silicon
High Frequency Transistor

... designed for amplifier and oscillator applications in industrial equipment constructed with surface mount components.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Complement to MRF5160
- Tape and Reel Packaging Options Available

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	V
Collector-Base Voltage	V_{CBO}	55	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current — Continuous	I_C	0.4	A
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	55	—	—	V
Collector-Emitter Sustaining Voltage ($I_E = 5\text{ mA}$)	$V_{CEO(sus)}$	30	—	—	V
Collector-Base Breakdown Voltage ($I_C = 0.1\text{ mA}$)	$V_{(BR)CBO}$	55	—	—	V
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$)	$V_{(BR)EBO}$	3.5	—	—	V
Collector Cutoff Current ($V_{CE} = 28\text{ V}$)	I_{CEO}	—	—	20	μA
Collector Cutoff Current ($V_{CE} = 55\text{ V}$, $V_{BE} = -1.5\text{ V}$ Reverse)	I_{CEX}	—	—	100	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 0.36\text{ A}$, $V_{CE} = 5\text{ V}$) ($I_C = 0.05\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	5 10	— —	— 200	—
Collector-Emitter Saturation Voltage ($I_C = 100\text{ mA}$, $I_B = 20\text{ mA}$)	$V_{CE(sat)}$	—	—	250	mV

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ V}$, $f = 200\text{ MHz}$)	f_T	—	800	—	MHz
Insertion Gain ($V_{CE} = 15\text{ V}$, $I_C = 50\text{ mA}$, $f = 400\text{ MHz}$)	$|S_{21}|^2$	8.5	10.5	—	dB
Output Capacitance ($V_{CB} = 30\text{ V}$, $f = 1\text{ MHz}$)	C_{obo}	—	—	3	pF

MRF3866

SURFACE MOUNT
RF TRANSISTOR
NPN SILICON



CASE 751-03
SO-8

COMMON EMITTER S-PARAMETERS

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			S11	$\angle \phi$	S21	$\angle \phi$	S12	$\angle \phi$	S22	$\angle \phi$
15	50	100	0.67	-166	13.75	92	0.016	44	0.32	-27
		200	0.69	-176	6.93	81	0.024	53	0.30	-24
		300	0.70	-177	4.57	73	0.032	57	0.32	-31
		400	0.71	-172	3.38	67	0.042	59	0.34	-37
		500	0.72	-168	2.66	61	0.049	59	0.37	-45
		600	0.72	-164	2.17	54	0.056	61	0.40	-53
		700	0.72	-160	1.85	49	0.061	63	0.43	-60
		800	0.72	-155	1.61	44	0.068	65	0.47	-66
		900	0.71	-151	1.40	39	0.075	64	0.50	-73
		1000	0.70	-146	1.25	34	0.084	68	0.53	-79

MRF4070

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed for 12.5 Volt VHF large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
 Output Power = 70 Watts
 Minimum Gain = 5.0 dB
 Efficiency = 55%
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Capable of Withstanding VSWR of 20:1 at Rated P_{out} and 15.5 V

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Peak	I_C	20	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate Above 25°C	P_D	250 1.43	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

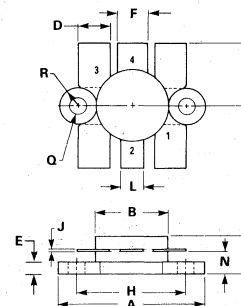
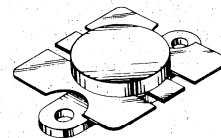
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	$^\circ\text{C/W}$

70 W 175 MHz

**CONTROLLED Q
 RF POWER
 TRANSISTOR**

NPN SILICON



STYLE 1:
 PIN 1. EMITTER
 2. COLLECTOR
 3. EMITTER
 4. BASE

NOTE:
 FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 12.5\text{ Vdc}$, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CES}	—	—	10	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	275	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 70\text{ Watts}$, $f = 175\text{ MHz}$)	G_{PE}	5.0	—	—	dB
Input Power ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 70\text{ Watts}$, $f = 175\text{ MHz}$)	P_{in}	—	—	20	Watts
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 70\text{ Watts}$, $f = 175\text{ MHz}$)	η	55	—	—	%

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC

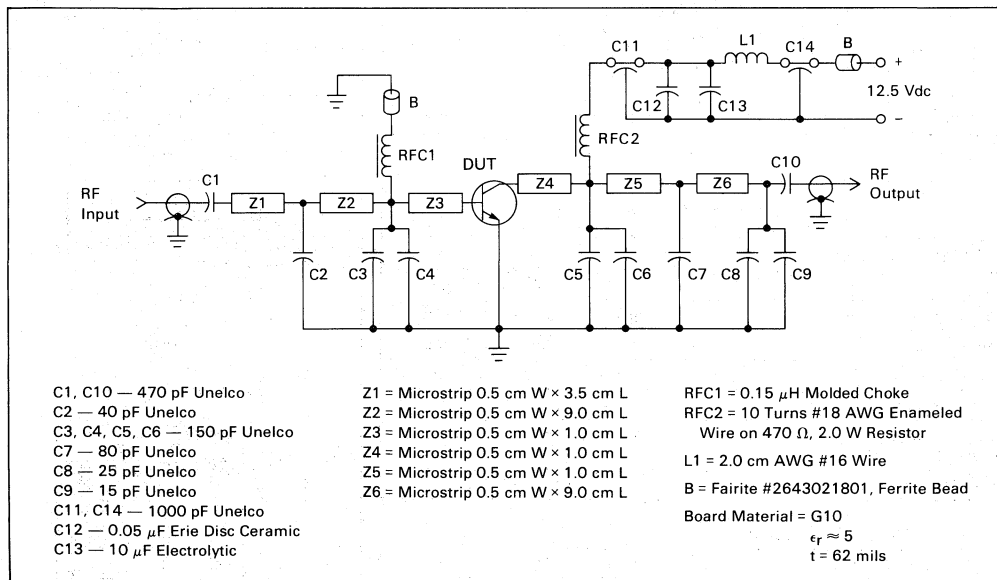


FIGURE 2 — OUTPUT POWER versus INPUT POWER

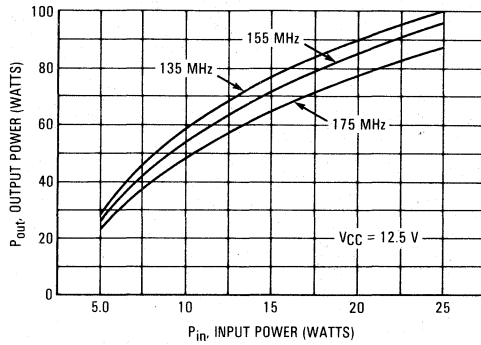


FIGURE 3 — OUTPUT POWER versus INPUT POWER

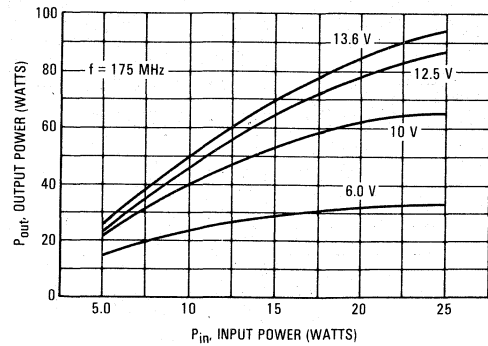


FIGURE 4 — OUTPUT POWER versus FREQUENCY

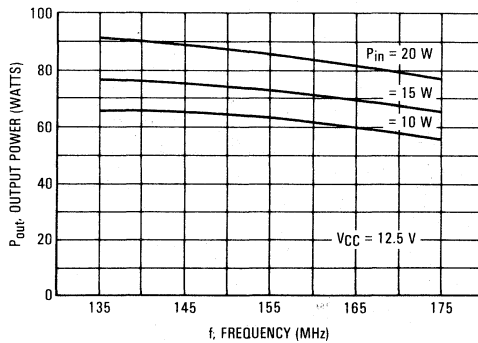
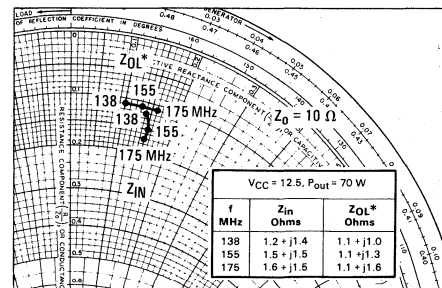


FIGURE 5 — SERIES EQUIVALENT IMPEDANCE



*Z_L = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE

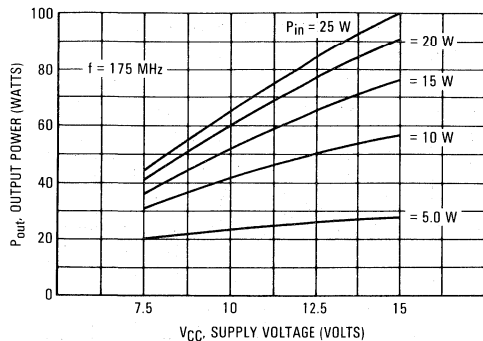


FIGURE 7 — OUTPUT POWER versus VOLTAGE

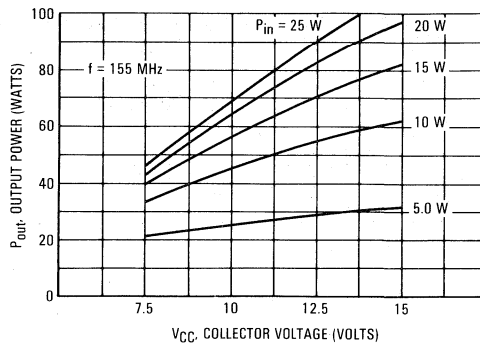


FIGURE 8 — OUTPUT POWER versus VOLTAGE

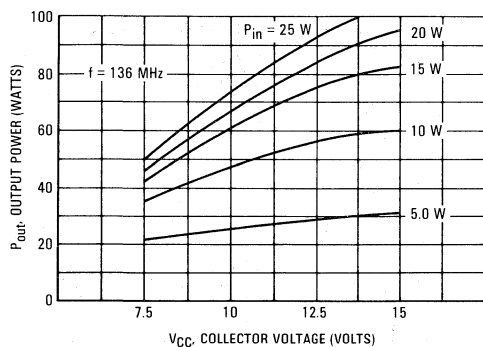
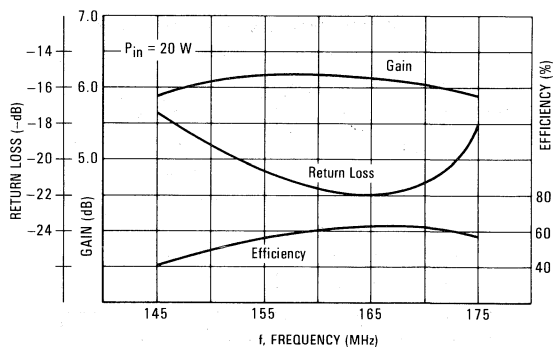


FIGURE 9 — BROADBAND PERFORMANCE GAIN, RETURN LOSS, EFFICIENCY versus FREQUENCY



The RF Line **PNP Silicon** **High Frequency Transistor**

... designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Complement to MRF3866
- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

MRF5160

**SURFACE MOUNT
RF TRANSISTOR
PNP SILICON**



**CASE 751-03
SO-8**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	V
Collector-Base Voltage	V_{CBO}	60	V
Emitter-Base Voltage	V_{EBO}	4	V
Collector Current — Continuous	I_C	0.4	A
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Sustaining Voltage ($I_C = 5\text{ mA}$)	$V_{CEO(sus)}$	40	—	—	V
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$)	$V_{(BR)EBO}$	4	—	—	V
Collector Cutoff Current ($V_{CB} = 28\text{ V}$)	I_{CBO}	—	—	1	μA
Collector Cutoff Current ($V_{CE} = 60\text{ V}$)	I_{CES}	—	—	0.1	mA
Emitter Cutoff Current ($V_{CE} = 28\text{ V}$)	I_{CEO}	—	—	20	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}, V_{CE} = 5\text{ V}$)	h_{FE}	10	—	—	—
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SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 50\text{ mA}, V_{CE} = 15\text{ V}, f = 200\text{ MHz}$)	f_T	—	800	—	MHz
Insertion Gain ($V_{CE} = 15\text{ V}, I_C = 50\text{ mA}, f = 400\text{ MHz}$)	$|S_{21}|^2$	8	9.8	—	dB

COMMON EMITTER S-PARAMETERS

V _{CE} (Volts)	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
15	50	100	0.78	-172	12.27	93	0.011	38	0.34	-29
		200	0.79	178	6.24	82	0.017	54	0.31	-31
		300	0.79	172	4.12	74	0.025	64	0.31	-39
		400	0.80	167	3.07	68	0.031	66	0.33	-48
		500	0.80	163	2.45	61	0.039	70	0.35	-56
		600	0.79	159	2.01	55	0.047	71	0.38	-64
		700	0.78	155	1.71	49	0.054	74	0.40	-71
		800	0.78	151	1.49	44	0.064	75	0.43	-79
		900	0.77	146	1.30	38	0.073	76	0.46	-86
		1000	0.76	142	1.16	33	0.083	77	0.50	-92

MRF5174

The RF Line

NPN SILICON RF POWER TRANSISTOR

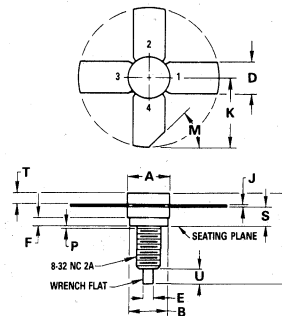
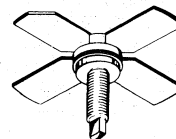
...designed primarily for wideband large-signal driver and pre-driver amplifier stages in the 260-600 MHz frequency range.

- Specified 28-Volt, 400-MHz Characteristics —
Output Power = 2.0 Watts
Minimum Gain = 12 dB
Efficiency = 50%
- Characterized from 200 to 600 MHz
- Includes Series Equivalent Impedances

2 W — 400 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	5.0 28	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

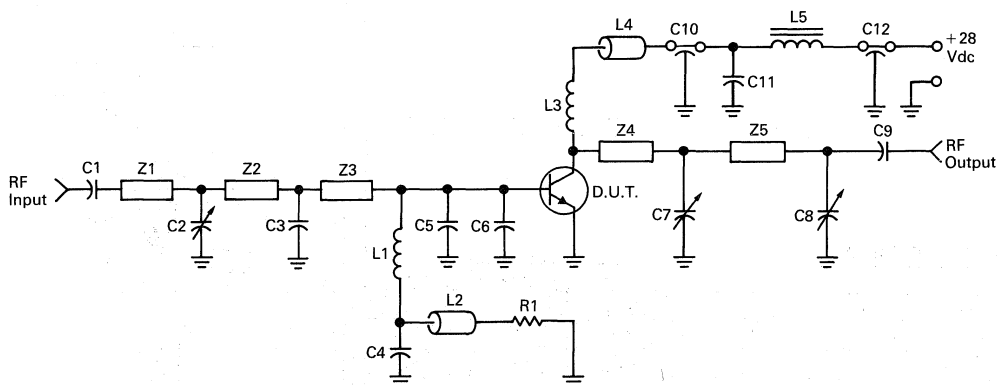
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.1	mA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	8.0	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 2.0\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	12	—	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 2.0\text{ W}$, $f = 400\text{ MHz}$)	η	50	—	—	%

FIGURE 1 — 400 MHz TEST CIRCUIT SCHEMATIC



- C1, 9 — 0.02 μF Chip
 C2 — 0.0–10 pF Johanson 2951
 C3 — 15 pF Unelco
 C4 — 100 pF Unelco
 C5, 6 — 5.1 pF ATC 100 mil Chip
 C7, 8 — 0.8–20 pF Johanson 3906
 C10, 12 — 680 pF Feedthru
 C11 — 1.0 μF Tantalum 35 V

R1 — 2.7 Ohm 1/2 Watt

- L1 — 3.9 μH Molded Choke
 L2, 4 — Ferrite Bead Ferroxcube 56-590-65-38
 L3 — 0.15 μH Molded Choke
 L5 — Ferrite Choke VK200-20-4B

Z1–Z5 — Microstrip, See Photomaster

Board Material — 0.062" Glass Teflon

FIGURE 2 – OUTPUT POWER versus FREQUENCY

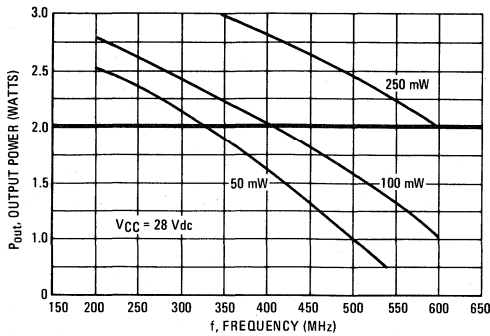


FIGURE 3 – OUTPUT POWER versus INPUT POWER

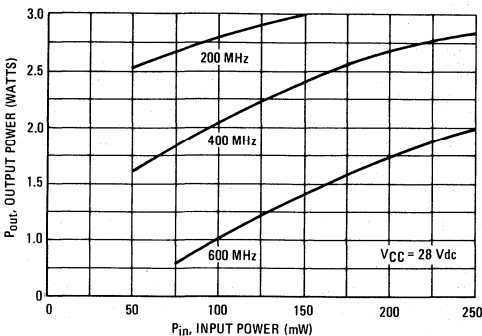


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

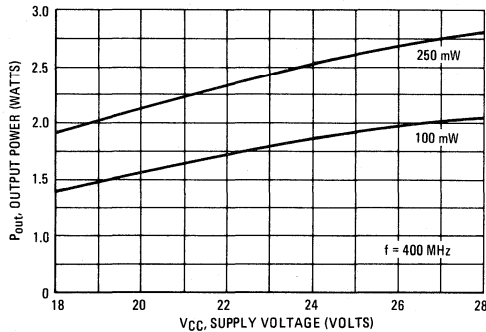


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE

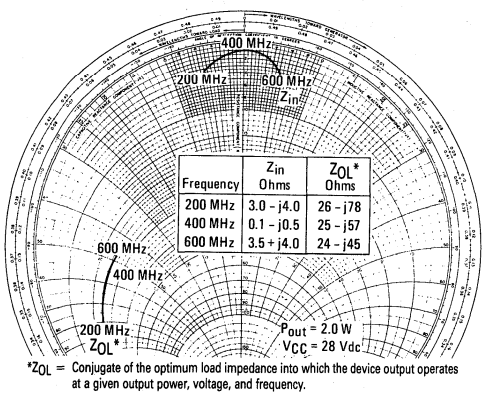
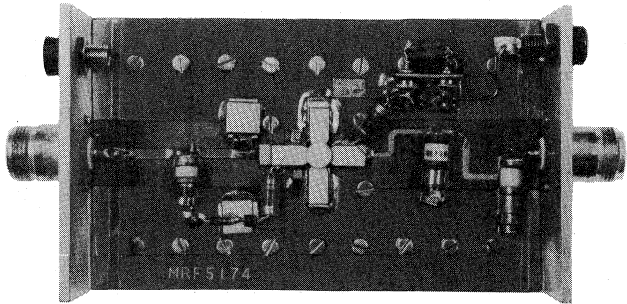


FIGURE 6 – 400 MHz TEST CIRCUIT



MRF5175

The RF Line

NPN SILICON RF POWER TRANSISTOR

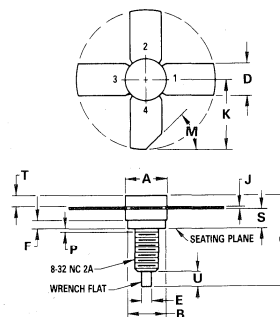
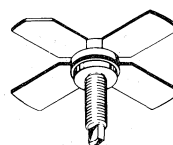
... designed primarily for wideband large-signal driver and predriver amplifier stages in the 200-600 MHz frequency range.

- Specified 28-Volt, 400-MHz Characteristics —
Output Power = 5.0 Watts
Minimum Gain = 11 dB
Efficiency = 50%
- Characterized from 200 to 600 MHz
- Includes Series Equivalent Impedances

5 W — 400 MHz

**RF POWER
TRANSISTOR**

NPN SILICON



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	12 69	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mAdc}$, $I_B = 0$)	$V_{(BR)CEO}$	33	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 30\text{ mAdc}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0\text{ mAdc}$, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$)	C_{ob}	—	—	15	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 400\text{ MHz}$)	G_{pE}	11	—	—	dB
Collector Efficiency ($V_{CC} = 28\text{ Vdc}$, $P_{out} = 5.0\text{ W}$, $f = 400\text{ MHz}$)	η	50	—	—	%

FIGURE 1 – 400 MHz TEST CIRCUIT SCHEMATIC

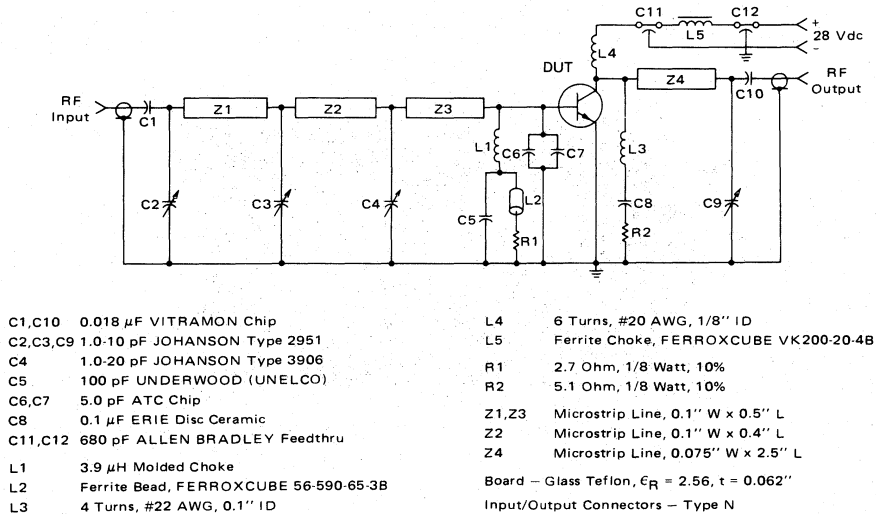


FIGURE 2 — OUTPUT POWER versus FREQUENCY

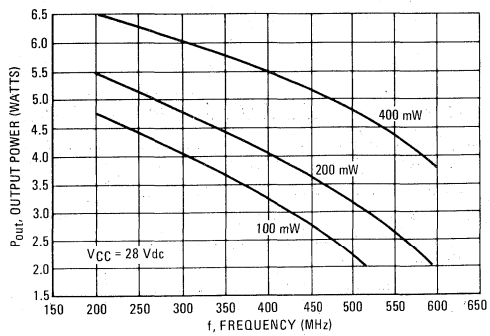


FIGURE 3 — OUTPUT POWER versus INPUT POWER

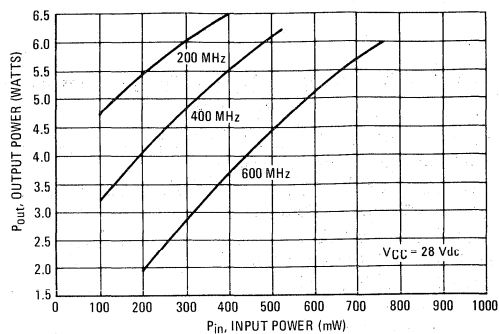


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

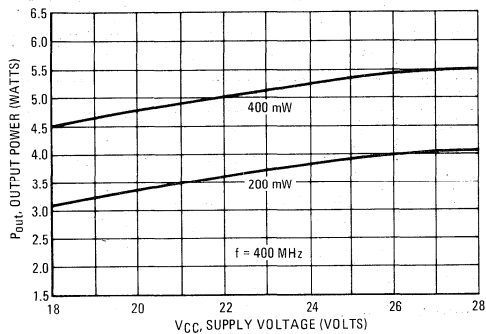


FIGURE 5 — SERIES EQUIVALENT IMPEDANCE

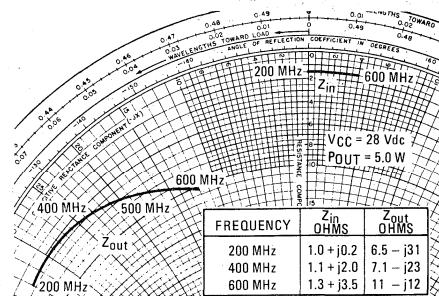
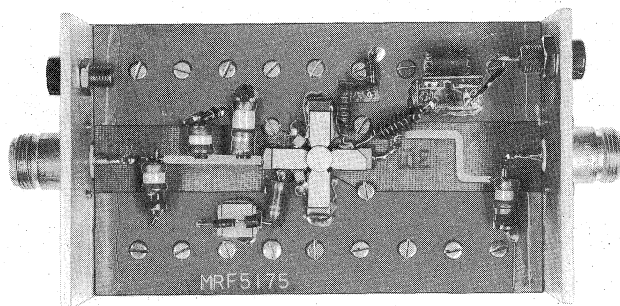


FIGURE 6 — 400 MHz TEST CIRCUIT



The RF Line **PNP Silicon** **High Frequency Transistor**

... designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

MRF5583

DIE SOURCE SAME AS
2N5583

SURFACE MOUNT
RF TRANSISTOR
PNP SILICON



CASE 751-03
SO-8

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	V
Collector-Base Voltage	V_{CBO}	30	V
Emitter-Base Voltage	V_{EBO}	3	V
Collector Current — Continuous	I_C	500	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$)	$V_{(BR)CEO}$	30	—	—	V
Collector-Base Breakdown Voltage ($I_C = 10\text{ }\mu\text{A}$)	$V_{(BR)CBO}$	30	—	—	V
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{A}$)	$V_{(BR)EBO}$	3	—	—	V
Collector Cutoff Current ($V_{CB} = 20\text{ V}$)	I_{CBO}	—	—	50	nA
Emitter Cutoff Current ($V_{EB} = 2\text{ V}$)	I_{EBO}	—	—	0.5	μA

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

ON CHARACTERISTICS

DC Current Gain ($I_C = 40\text{ mA}, V_{CE} = 2\text{ V}$) ($I_C = 100\text{ mA}, V_{CE} = 2\text{ V}$) ($I_C = 300\text{ mA}, V_{CE} = 5\text{ V}$)	h_{FE}	20 25 15	— — —	— 100 —	—
Collector-Emitter Saturation Voltage ($I_C = 100\text{ mA}, I_B = 10\text{ mA}$)	$V_{CE(sat)}$	—	—	0.8	V
Base-Emitter On Voltage ($I_C = 100\text{ mA}, V_{CE} = 2\text{ V}$)	$V_{BE(on)}$	—	—	1.8	V

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 35\text{ mA}, V_{CE} = 15\text{ V}, f = 100\text{ MHz}$)	f_T	—	2100	—	MHz
Insertion Gain ($V_{CE} = 15\text{ V}, I_C = 35\text{ mA}, f = 250\text{ MHz}$)	$|S_{21}|^2$	12.5	15.5	—	dB

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle\phi$	$|S_{21}|$	$\angle\phi$	$|S_{12}|$	$\angle\phi$	$|S_{22}|$	$\angle\phi$
15	35	10	0.47	-57	64.7	155	0.01	60	0.83	-26
		30	0.59	-116	42.2	126	0.02	44	0.56	-58
		50	0.63	-140	28.8	113	0.02	39	0.39	-74
		70	0.64	-151	21.4	105	0.02	42	0.3	-82
		100	0.65	-161	15.4	97	0.02	45	0.24	-90
		300	0.67	179	5.23	79	0.05	58	0.13	-109
		500	0.67	168	3.11	66	0.07	60	0.2	-114
		700	0.67	160	2.24	57	0.09	60	0.24	-116
		1000	0.66	146	1.54	44	0.13	60	0.3	-123

The RF Line **NPN Silicon** **High-Frequency Transistors**

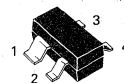
... designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching times.

- High Current-Gain-Bandwidth Product — $f_T = 7.5$ GHz (Typ) @ $I_C = 50$ mAdc
- Low Noise Figure @ $f = 1$ GHz — $NF_{(matched)} = 1.6$ dB (Typ)
- High Power Gain — G_{pe} (matched) = 13.5 dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance
- Lower Package Parasitics
- Higher Gain
- Available In Both Standard Profile (MRF5711) and Low Profile (MRF5711L)
- Tape and Reel Packaging Options

MRF5711
BF430*
MRF5711L
BF430L*

*European Part Numbers

SURFACE MOUNTED
HIGH FREQUENCY
TRANSISTORS
NPN SILICON



CASE 318B-03, STYLE 1
SOT-143

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	0.58 4.64	Watts mW/ $^\circ\text{C}$
Total Device Dissipation ⁽¹⁾ @ $T_C = 75^\circ\text{C}$ Derate above 75°C	P_D	0.58 7.73	Watts mW/ $^\circ\text{C}$
Maximum Junction Temperature	T_{Jmax}	150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	216	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	130	$^\circ\text{C/W}$

DEVICE MARKING

MRF5711 = 02

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 50$ μAdc , $I_C = 0$)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 8$ Vdc, $I_E = 0$)	I_{CBO}	—	—	10	μAdc

Note 1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain ($I_C = 30\text{ mA}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 6\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{cb}	—	0.75	1	pF
Current Gain — Bandwidth Product ($V_{CE} = 8\text{ Vdc}$, $I_C = 50\text{ mA}$, $f = 1\text{ GHz}$)	f_T	—	7.5	—	GHz
FUNCTIONAL TESTS					
Power Gain at Minimum Noise Figure ($V_{CE} = 6\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	GNF_{min}	—	13.5	—	dB
Noise Figure ($V_{CE} = 6\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	NF_{min}	—	1.6	—	dB
Power Gain in $50\ \Omega$ System ($V_{CE} = 6\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	GNF	9	10	—	dB
Noise Figure ($V_{CE} = 6\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	NF	—	2.2	3	dB

TYPICAL CHARACTERISTICS

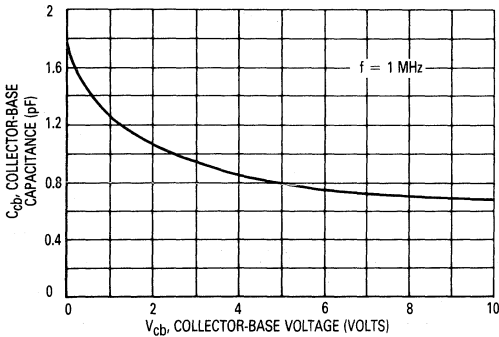


Figure 1. Collector-Base Capacitance versus Collector-Base Voltage

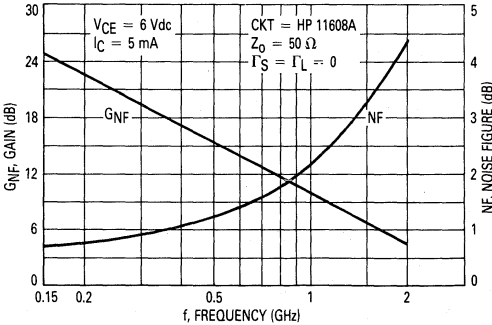


Figure 2. Gain and Noise Figure versus Frequency

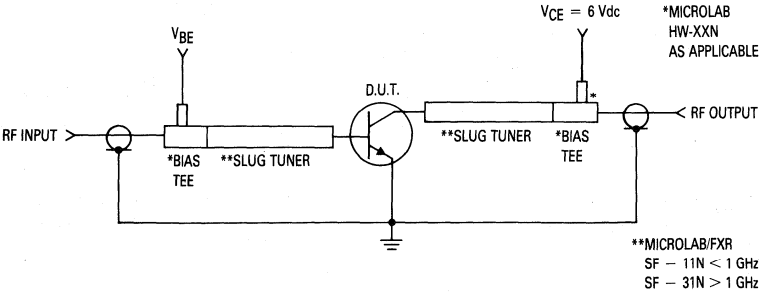


Figure 3. Functional Circuit Schematic

TYPICAL CHARACTERISTICS

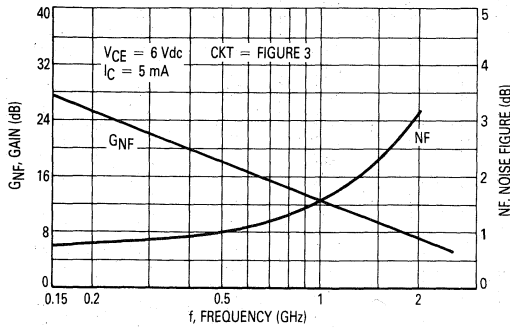


Figure 4. Gain and Noise Figure versus Frequency

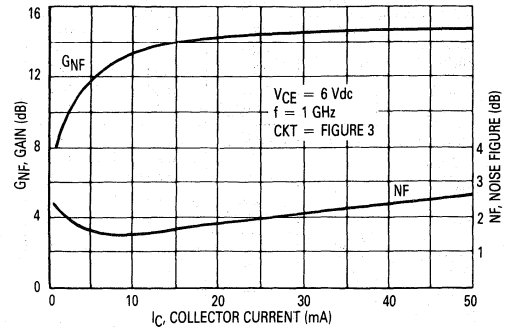


Figure 5. Gain and Noise Figure versus Collector Current

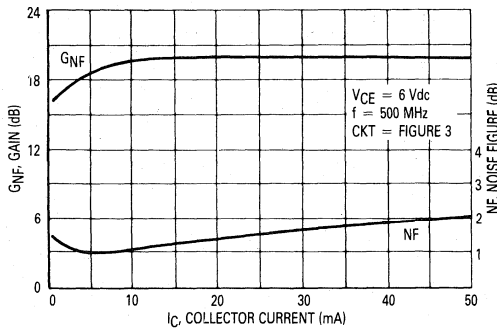


Figure 6. Gain and Noise Figure versus Collector Current

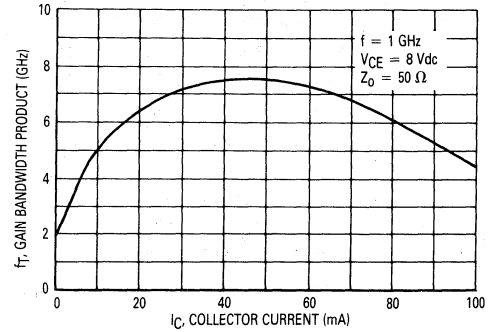


Figure 7. Gain Bandwidth Product versus Collector Current

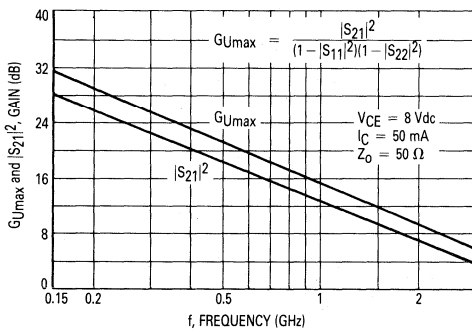
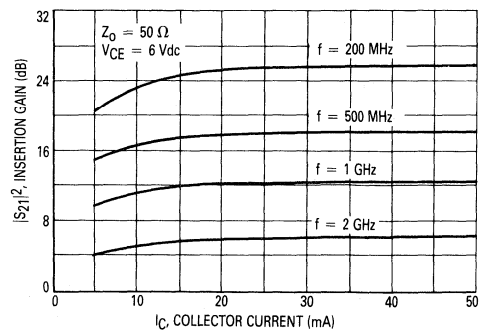
Figure 8. G_{Umax} and $|S_{21}|^2$ versus Frequency

Figure 9. Insertion Gain versus Collector Current

V _{CE} (V _{dc})	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
6	5	200	0.79	-90	10.9	128	0.06	46	0.70	-45
		500	0.72	-144	5.7	96	0.08	28	0.42	-66
		1000	0.69	-177	3	75	0.09	28	0.31	-77
		1500	0.66	164	2	59	0.10	32	0.34	-89
		2000	0.65	147	1.6	47	0.12	38	0.32	-94
	10	200	0.72	-115	15.2	118	0.05	41	0.55	-66
		500	0.69	-160	6.9	92	0.06	34	0.30	-92
		1000	0.67	174	3.6	74	0.08	42	0.21	-108
		1500	0.64	159	2.4	60	0.10	46	0.23	-114
		2000	0.64	143	1.8	49	0.12	50	0.20	-116
	50	200	0.67	-159	20	102	0.02	48	0.33	-111
		500	0.67	179	8.2	85	0.04	58	0.33	-142
		1000	0.66	174	3.8	72	0.07	65	0.21	-158
		1500	0.63	151	2.7	61	0.10	64	0.22	-158
		2000	0.58	138	2.1	51	0.14	62	0.17	-165
8	5	200	0.80	-87	11.1	130	0.06	47	0.71	-42
		500	0.72	-141	5.9	97	0.08	30	0.44	-60
		1000	0.70	-177	3.1	75	0.09	28	0.33	-68
		1500	0.66	166	2.1	60	0.10	32	0.35	-80
		2000	0.61	149	1.6	47	0.12	39	0.35	-85
	10	200	0.72	-113	15.6	119	0.05	42	0.56	-61
		500	0.68	-159	7.2	92	0.06	34	0.31	-82
		1000	0.66	175	3.7	74	0.08	41	0.21	-92
		1500	0.64	160	2.5	61	0.09	47	0.23	-101
		2000	0.60	144	2	49	0.13	50	0.21	-103
	50	200	0.66	-156	20.9	103	0.02	48	0.31	-101
		500	0.65	-179	8.6	85	0.04	58	0.19	-128
		1000	0.64	164	4.3	72	0.07	65	0.16	-144
		1500	0.61	153	2.9	61	0.10	65	0.17	-142
		2000	0.58	137	2.3	51	0.13	64	0.14	145

Figure 10. Common Emitter S-Parameters

The RF Line
NPN Silicon
RF Low Power Transistor

... designed for high current, low power amplifiers up to 2 GHz.

- High Current Gain-Bandwidth Product — $f_T = 5.5$ GHz (Typ) @ $I_C = 75$ mA
- Low Noise — 2 dB (Typ) @ 500 MHz
- Low Intermodulation Distortion
- High Gain — 15.5 dB (Typ) @ 500 MHz
- Low Cost SORF Plastic Surface Mount Package
- State-of-the-Art Technology
 - Fine Line Geometry
 - Gold Top Metal and Wires
 - Silicon Nitride Passivated
 - Ion Implanted Arsenic Emitters
- Die Same as MRF581,A

MRF5812
BF433*

*European Part Number

SURFACE MOUNT
LOW POWER
TRANSISTOR
NPN SILICON



CASE 751-03, STYLE 1
SORF
(SO-8)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE}	15	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	2.5	Vdc
Collector-Current — Continuous	I_C	200	mA
Total Device Dissipation @ $T_C = 80^\circ\text{C}$ (1) Derate above 80°C	P_D	1.5 22.2	Watts mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1.5 11.8	Watts mW/ $^\circ\text{C}$
Operating Junction and Storage Temperature Range	T_J, T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	$^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	85	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5$ mA, $I_B = 0$)	$V_{(BR)CE}$	15	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EB}$	2.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $V_{BE} = 0$, $T_C = 25^\circ\text{C}$)	I_{CBO}	—	—	0.1	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 10$ Vdc)	h_{FE}	30	90	200	—
---	----------	----	----	-----	---

(1) Case temperature is measured on the collector lead where the lead contacts the printed circuit board closest to the body of the package.

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Collector Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{cb}	—	1.2	2	pF
Current-Gain Bandwidth Product (1) ($I_C = 75\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 1\text{ GHz}$)	f_T	—	5.5	—	GHz

FUNCTIONAL TESTS

Noise Figure (Optimum) ($I_C = 50\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$) Figure 4	NF	—	2	—	dB
Noise Figure (50 Ohm Insertion) ($I_C = 50\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$) Figure 5	NF	—	2.5	3	dB
Power Gain Associated with Noise Figure ($I_C = 50\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$) Figure 5	G_{NF}	13	15.5	—	dB
Maximum Unilateral Gain (1) ($I_C = 75\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 0.5\text{ GHz}$)	G_{Umax}	—	17	—	dB
Intermodulation Distortion (2) Figure 1 ($V_{CE} = 10\text{ V}$, $I_C = 75\text{ mA}$, $V_{out} = +50\text{ dBmV}$)	IMD(d3)	—	-65	—	dB

Notes: (1) Characterized on HP8542 Automatic Network Analyzer. $G_{Umax} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$
 (2) 2 Tones, $f_1 = 497\text{ MHz}$, $f_2 = 503\text{ MHz}$, 3rd Order Single Tone Reference.

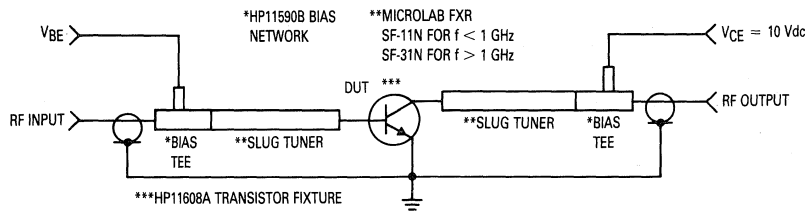


Figure 1. Functional Circuit Schematic

TYPICAL CHARACTERISTICS

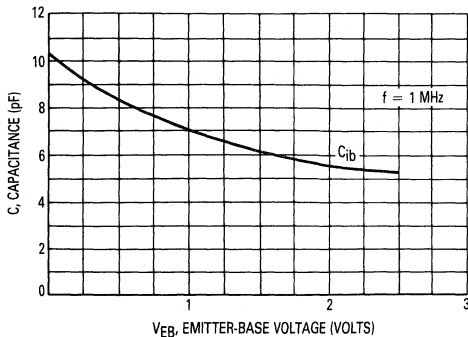


Figure 2. C_{ib} Input Capacitance versus Voltage

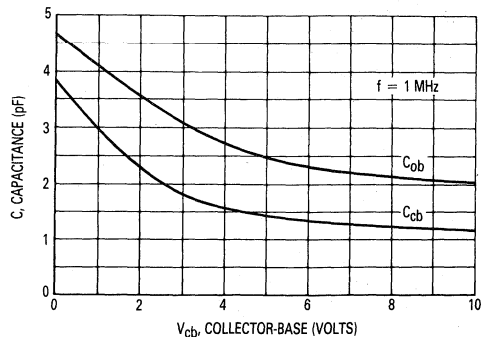


Figure 3. C_{cb} , C_{ob} Collector-Base Capacitance versus Voltage

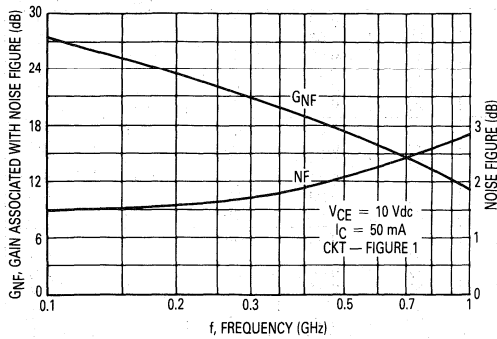


Figure 4. Noise Figure and Gain Associated with Noise Figure versus Frequency

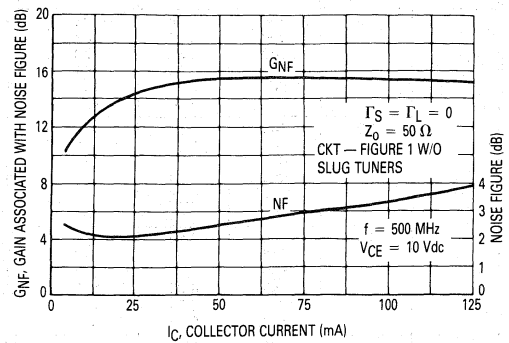


Figure 5. Noise Figure and Gain Associated with Noise Figure versus Collector Current

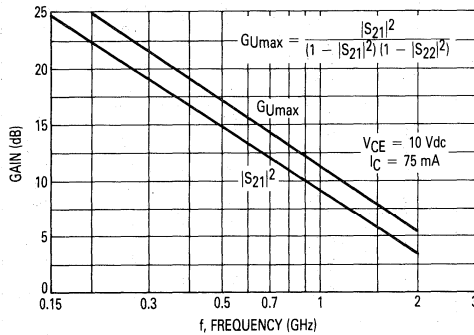


Figure 6. G_{Ummax} — Maximum Unilateral Gain, $|S_{21}|^2$ versus Frequency

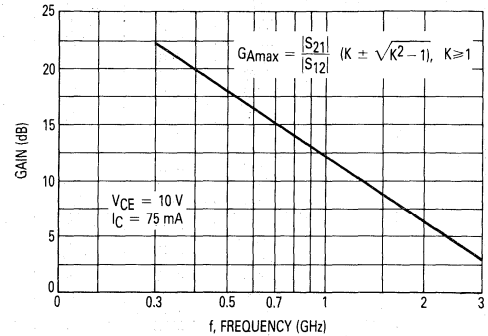


Figure 7. G_{Ammax} , Maximum Available Gain versus Frequency

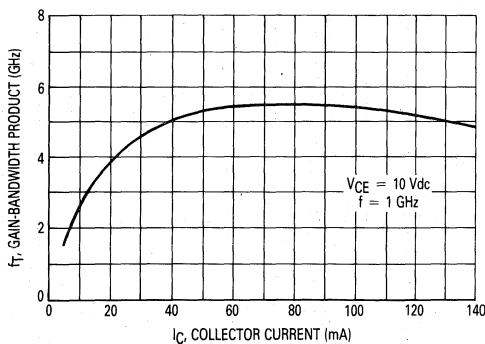


Figure 8. Gain-Bandwidth Product versus Collector Current

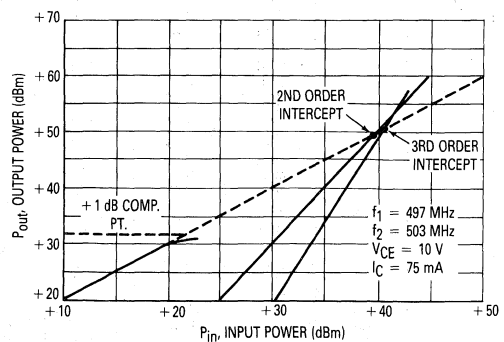


Figure 9. 2nd and 3rd Order Intercept Points and 1 dB Compression Point

VCE (Volts)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
5	25	100	0.66	-123	18.3	118	0.04	43	0.53	-79
		300	0.66	-167	7	92	0.06	44	0.31	-120
		500	0.65	178	4.3	81	0.08	52	0.28	-133
		1000	0.62	154	2.2	63	0.13	61	0.28	-141
		2000	0.57	109	1.3	39	0.28	57	0.31	-148
		3000	0.55	68	1	23	0.41	41	0.34	-164
	50	100	0.64	-133	20.2	114	0.04	44	0.51	-93
		300	0.65	-171	7.6	91	0.06	50	0.34	-137
		500	0.65	175	4.6	81	0.08	56	0.31	-148
		1000	0.61	152	2.3	63	0.13	63	0.28	-149
		2000	0.56	109	1.3	39	0.28	57	0.3	-150
		3000	0.52	70	1	23	0.41	39	0.29	-169
	75	100	0.64	-137	20.8	113	0.04	44	0.5	-99
		300	0.66	-173	7.7	91	0.06	52	0.35	-142
		500	0.64	174	4.7	82	0.08	59	0.32	-154
		1000	0.61	151	2.4	65	0.14	64	0.3	-164
		2000	0.54	107	1.4	42	0.3	55	0.27	-167
		3000	0.52	69	1.1	24	0.42	37	0.25	-172
	100	100	0.64	-140	20.8	112	0.03	44	0.5	-103
		300	0.65	-174	7.6	90	0.06	53	0.36	-145
		500	0.64	173	4.7	81	0.08	60	0.33	-156
		1000	0.61	151	2.4	65	0.15	64	0.31	-166
		2000	0.54	107	1.4	42	0.3	54	0.27	-169
		3000	0.52	65	1.1	24	0.42	37	0.25	-174
10	25	100	0.65	-112	20.2	121	0.04	46	0.56	-62
		300	0.63	-162	8	93	0.05	46	0.29	-93
		500	0.62	-178	5	82	0.07	52	0.25	-102
		1000	0.6	157	2.5	63	0.11	63	0.26	-112
		2000	0.55	112	1.4	39	0.25	61	0.35	-125
		3000	0.55	69	1	23	0.39	47	0.4	-145
	50	100	0.63	-122	22.9	117	0.03	46	0.5	-74
		300	0.62	-167	8.8	92	0.05	51	0.28	-112
		500	0.6	178	5.3	82	0.07	58	0.24	-122
		1000	0.58	154	2.7	64	0.12	65	0.23	-129
		2000	0.51	111	1.5	40	0.26	59	0.28	-132
		3000	0.5	70	1.2	24	0.39	44	0.34	-144
	75	100	0.63	-126	23.8	116	0.03	45	0.49	-80
		300	0.63	-168	9	92	0.05	51	0.28	-120
		500	0.62	177	5.5	82	0.07	58	0.24	-130
		1000	0.58	154	2.8	65	0.12	65	0.23	-137
		2000	0.52	111	1.5	41	0.26	58	0.27	-135
		3000	0.5	70	1.2	24	0.39	42	0.32	-145
	100	100	0.62	-128	23.8	114	0.03	46	0.46	-82
		300	0.62	-169	8.9	91	0.05	54	0.26	-120
		500	0.6	176	5.4	81	0.07	61	0.23	-130
		1000	0.57	152	2.8	64	0.12	66	0.21	-136
		2000	0.51	109	1.5	40	0.27	59	0.26	-134
		3000	0.5	68	1.2	24	0.39	43	0.32	-145
15	25	100	0.66	-106	21	123	0.03	47	0.57	-54
		300	0.63	-159	8.5	94	0.05	46	0.3	-77
		500	0.61	-177	5.2	82	0.06	52	0.26	-84
		1000	0.58	156	2.6	62	0.11	64	0.28	-96
		2000	0.54	110	1.4	36	0.23	63	0.39	-115
		3000	0.56	68	1	22	0.37	49	0.46	-137
	50	100	0.62	-114	24	119	0.03	46	0.51	-64
		300	0.6	-163	9.2	93	0.05	51	0.26	-92
		500	0.58	-179	5.7	81	0.07	58	0.22	-100
		1000	0.56	154	2.9	63	0.12	66	0.23	-109
		2000	0.52	109	1.5	39	0.25	60	0.32	-118
		3000	0.52	67	1.1	22	0.37	46	0.39	-137
	75	100	0.62	-118	24.6	117	0.03	46	0.48	-67
		300	0.59	-165	9.4	92	0.05	53	0.24	-96
		500	0.58	179	5.7	81	0.07	60	0.21	-104
		1000	0.56	154	2.9	63	0.12	66	0.22	-111
		2000	0.5	109	1.5	38	0.25	60	0.31	-118
		3000	0.52	67	1.1	22	0.37	46	0.38	-136
	100	100	0.62	-121	24.8	116	0.03	46	0.46	-68
		300	0.6	-165	9.3	91	0.05	53	0.23	-96
		500	0.58	179	5.7	81	0.07	61	0.2	-102
		1000	0.56	155	2.9	63	0.12	65	0.22	-109
		2000	0.5	111	1.5	39	0.25	62	0.32	-117
		3000	0.5	68	1.1	23	0.37	47	0.39	-136

Figure 10. Common Emitter S-Parameters

The RF Line
NPN Silicon
High Frequency Transistor

... designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

MRF5943

DIE SOURCE SAME AS
2N5943

SURFACE MOUNT
RF TRANSISTOR
NPN SILICON



CASE 751-03
SO-8

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	V
Collector-Base Voltage	V_{CBO}	40	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current — Continuous	I_C	400	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Collector-Emitter Breakdown Voltage ($I_C = 5\text{ mA}$)	$V_{(BR)CEO}$	30	—	—	V
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$)	$V_{(BR)CBO}$	40	—	—	V
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{A}$)	$V_{(BR)EBO}$	3.5	—	—	V
Collector Cutoff Current ($V_{CE} = 20\text{ V}$)	I_{CEO}	—	—	50	μA
Collector Cutoff Current ($V_{CB} = 15\text{ V}$)	I_{CBO}	—	—	10	μA

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 15\text{ V}$)	h_{FE}	25	—	300	—
Collector-Emitter Saturation Voltage ($I_C = 100\text{ mA}$, $I_B = 10\text{ mA}$)	$V_{CE(sat)}$	—	—	0.2	V
Base-Emitter Saturation Voltage ($I_C = 100\text{ mA}$, $I_B = 10\text{ mA}$)	$V_{BE(sat)}$	—	—	1.0	V

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 35\text{ mA}$, $V_{CE} = 15\text{ V}$, $f = 100\text{ MHz}$)	f_T	—	1550	—	MHz
Insertion Gain ($V_{CE} = 15\text{ V}$, $I_C = 35\text{ mA}$, $f = 250\text{ MHz}$)	$|S_{21}|^2$	12	15	—	dB

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle\phi$	$|S_{21}|$	$\angle\phi$	$|S_{12}|$	$\angle\phi$	$|S_{22}|$	$\angle\phi$
15	35	10	0.37	-63	53.7	157	0.01	59	0.91	-18
		30	0.52	-120	36.5	128	0.01	48	0.64	-38
		50	0.58	-142	25.4	113	0.02	45	0.47	-44
		70	0.59	-154	19	105	0.02	46	0.38	-44
		100	0.60	-162	13.6	97	0.02	49	0.32	-43
		300	0.64	-178	4.6	77	0.05	59	0.28	-49
		500	0.65	-168	2.8	64	0.07	60	0.32	-62
		700	0.65	-159	2	53	0.09	63	0.38	-76
		1000	0.64	-144	1.4	38	0.13	63	0.46	-93

The RF Line
NPN Silicon
RF Low Power Transistor

... designed primarily for wideband large signal predriver stages in 800 MHz and UHF frequency ranges.

- Specified @ 12.5 V, 870 MHz Characteristics
 - Output Power = 750 mW
 - Common Emitter Power Gain = 10 dB (Typ)
 - Efficiency 60% (Typ)
- Low Cost SORF Plastic Surface Mounted Package
- State-of-the-Art Technology
 - Fine Line Geometry
 - Gold Top Metal and Wires
 - Silicon Nitride Passivated
 - Ion Implanted Arsenic Emitters

MRF8372

750 mW 870 MHz
RF LOW POWER
TRANSISTOR
NPN SILICON



CASE 751-03, STYLE 1
SORF
(SO-8)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	200	mA _{dc}
Total Device Dissipation @ $T_C = 80^\circ\text{C}$ (1) Derate above 80°C	P_D	1.5 22.2	Watts mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1.5 11.8	Watts mW/ $^\circ\text{C}$
Operating Junction and Storage Temperature Range	T_J, T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	$^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	85	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5 \text{ mA}_{dc}, I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 5 \text{ mA}_{dc}, V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}_{dc}, I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15 \text{ Vdc}, V_{BE} = 0, T_C = 25^\circ\text{C}$)	I_{CES}	—	—	0.1	mA _{dc}

ON CHARACTERISTICS

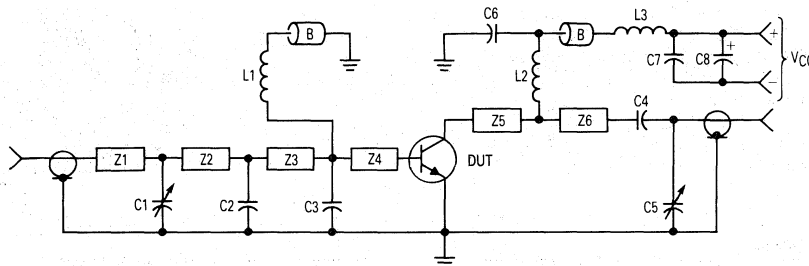
DC Current Gain ($I_C = 50 \text{ mA}_{dc}, V_{CE} = 10 \text{ Vdc}$)	h_{FE}	30	90	200	—
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(1) Case temperature is measured on the collector lead where the lead contacts the printed circuit board closest to the body of the package.

(continued)

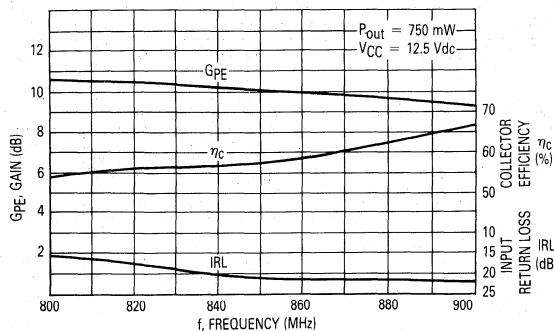
ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 15\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	1.8	2.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.75\text{ W}$, $f = 870\text{ MHz}$)	G_{pe}	8	10	—	dB
Collector Efficiency ($V_{CC} = 12.5\text{ Vdc}$, $P_{out} = 0.75\text{ W}$, $f = 870\text{ MHz}$)	η	55	60	—	%



C1, C5 — 0.8–8 pF Johanson Gigatrim
 C2, C3 — 10 pF Ceramic Chip Capacitor
 C6 — 91 pF Clamped Mica, Mini-Underwood
 C4 — 47 pF Ceramic Chip Capacitor
 C7 — 91 pF Clamped Mica, Mini-Underwood
 C8 — 1 μF 25 V Tantalum
 B — Bead, Ferroxcube 56-590-65/3B

L1, L2 — 4 Turns, #21 AWG, 5/32" ID
 L3 — 7 Turns, #21 AWG, 5/32" ID
 Z1, Z2 — 1" x 0.078" Microstrip, $Z_0 = 50\text{ Ohms}$
 Z3 — 0.25" x 0.078" Microstrip, $Z_0 = 50\text{ Ohms}$
 Z4 — 0.15" x 0.078" Microstrip, $Z_0 = 50\text{ Ohms}$
 Z5 — 0.30" x 0.078" Microstrip, $Z_0 = 50\text{ Ohms}$
 Z6 — 1.63" x 0.078" Microstrip, $Z_0 = 50\text{ Ohms}$
 PCB — 1/32" Glass Teflon, $\epsilon_r = 2.56$

Figure 1. 800–900 MHz Broadband Circuit**800/900 MHz BAND DATA****Figure 2. Typical Broadband Performance**

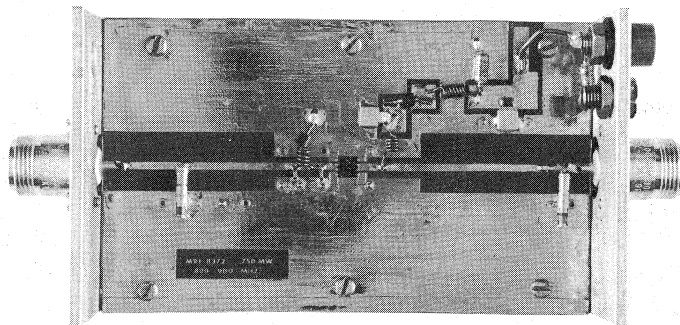
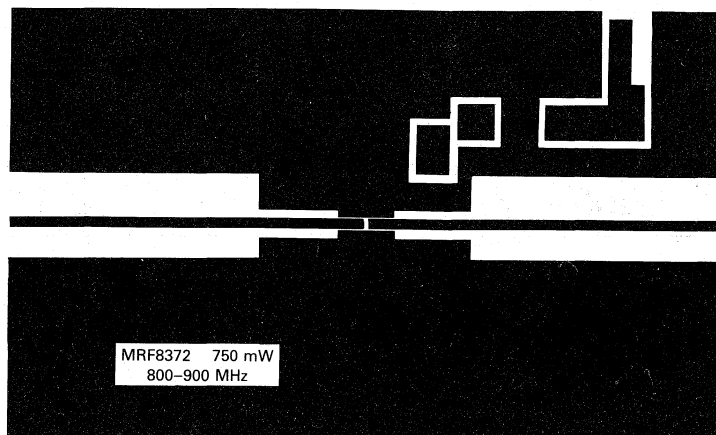


Figure 3. 800-900 Broadband Circuit



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 4. 800-900 MHz Broadband Circuit Photomaster

f Frequency MHz	Z_{in} Ohms		Z_{OL}^* Ohms	
	$V_{CC} = 7.5 \text{ V}$	$V_{CC} = 12.5 \text{ V}$	$V_{CC} = 7.5 \text{ V}$	$V_{CC} = 12.5 \text{ V}$
	$P_{in} = 150 \text{ mW}$	$P_{in} = 100 \text{ mW}$	$P_{out} \text{ 806 MHz} = 820 \text{ mW}$ $P_{out} \text{ 870 MHz} = 635 \text{ mW}$ $P_{out} \text{ 960 MHz} = 530 \text{ mW}$	$P_{out} \text{ 806 MHz} = 1.05 \text{ mW}$ $P_{out} \text{ 870 MHz} = 855 \text{ mW}$ $P_{out} \text{ 960 MHz} = 580 \text{ mW}$
806	$8.0 + j1.9$	$4.0 + j1.2$	$24.7 - j19.2$	$20.9 - j31.0$
870	$5.2 + j3.5$	$6.0 + j1.9$	$36.9 - j20.5$	$32.1 - j26.6$
960	$6.8 + j4.0$	$6.1 + j2.5$	$39.3 - j18.5$	$36.3 - j25.7$

* Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.Figure 5. Z_{in} and Z_{OL} versus Collector Voltage, Input Power and Output Power

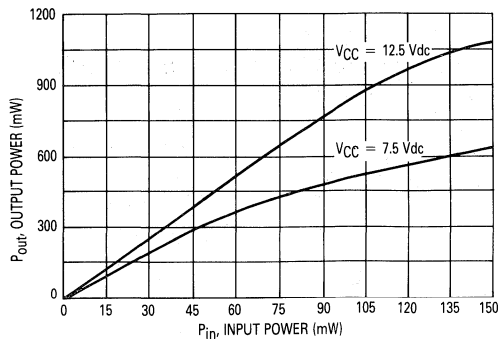


Figure 6. Output Power versus Input Power
 $f = 870$ MHz

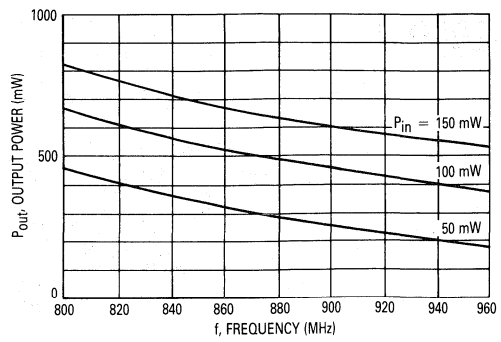


Figure 7. Output Power versus Frequency
 $V_{CC} = 7.5$ Vdc

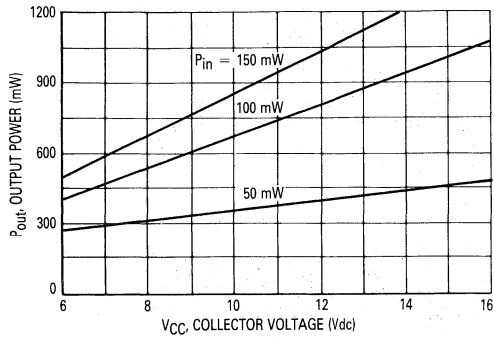


Figure 8. Output Power versus Collector Voltage
 $f = 870$ MHz

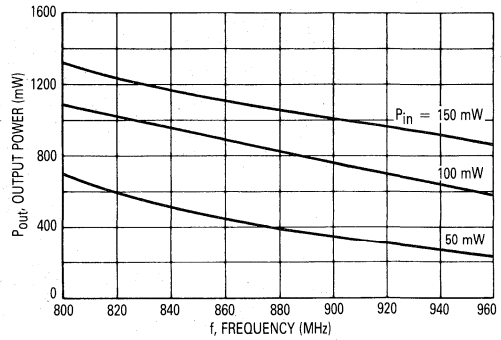


Figure 9. Output Power versus Frequency
 $V_{CC} = 12.5$ Vdc

The RF Line
NPN Silicon
High-Frequency Transistors

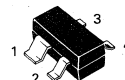
... designed primarily for use in high-gain, low-noise small-signal amplifiers for operation up to 2.5 GHz. Also usable in applications requiring fast switching times.

- High Current-Gain-Bandwidth Product — $f_T = 3.8$ GHz (Typ) @ $I_C = 15$ mAdc
- Low Noise Figure @ $f = 1$ GHz — $NF_{(matched)} = 1.8$ dB (Typ)
- High Power Gain — $G_{pe(matched)} = 13.5$ dB (Typ) @ $f = 1$ GHz
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance
 - Lower Package Parasitics
 - High Gain
- Available In Both Standard Profile (MRF9011) and Low Profile (MRF9011L)
- Tape and Reel Packaging Options

MRF9011
BF431*
MRF9011L
BF431L*

*European Part Numbers

SURFACE MOUNTED
HIGH FREQUENCY
TRANSISTORS
NPN SILICON



CASE 318B-03, STYLE 1
SOT-143

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2	Vdc
Collector-Current — Continuous	I_C	30	mAdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	0.30 3.3	Watt mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	300	$^\circ\text{C/W}$

DEVICE MARKING

MRF9011 = 01

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	2	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$)	I_{CBO}	—	—	50	nAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 5$ mAdc, $V_{CE} = 5$ Vdc)	h_{FE}	30	80	200	—
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(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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DYNAMIC CHARACTERISTICS

Current-Gain-Bandwidth Product ($I_C = 15\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f = 1\text{ GHz}$)	Figure 6	f_T	—	3.8	—	GHz
Collector-Base Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	Figure 1	C_{cb}	—	0.55	1	pF

FUNCTIONAL TESTS

Power Gain at Minimum Noise Figure ($V_{CE} = 10\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 5	GNF_{min}	—	13.5	—	dB
Noise Figure ($V_{CE} = 10\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 5	NF_{min}	—	1.8	—	dB
Power Gain in 50 Ω System ($V_{CE} = 10\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 2	GNF	9	10.2	—	dB
Noise Figure ($V_{CE} = 10\text{ Vdc}$, $I_C = 5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 2	NF	—	2.3	3	dB

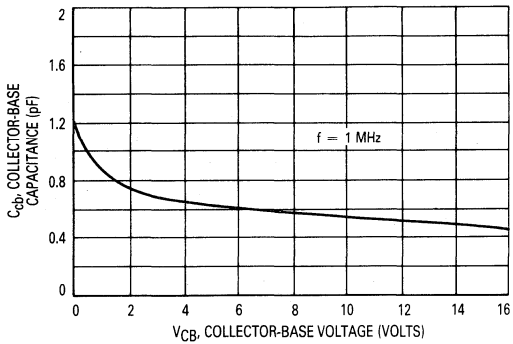


Figure 1. Collector-Base Capacitance versus Collector-Base Voltage

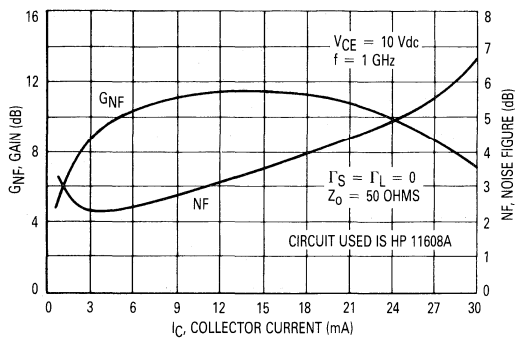


Figure 2. Gain and Noise Figure versus Collector Current

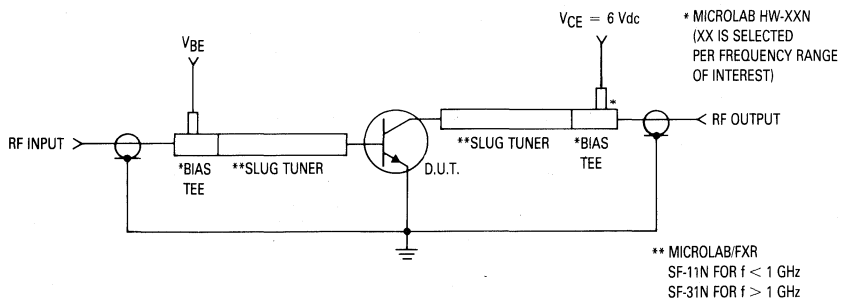


Figure 3. Functional Circuit Schematic

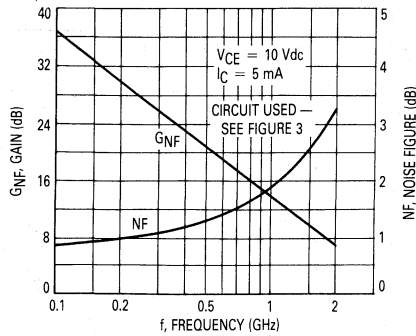


Figure 4. Gain and Noise Figure versus Frequency

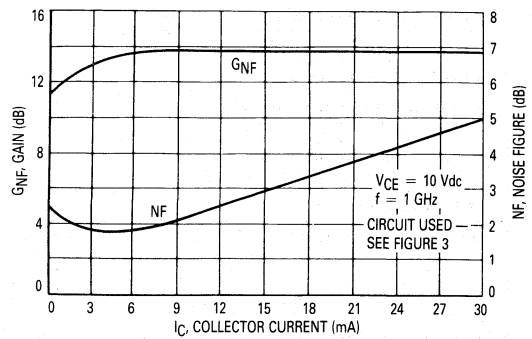


Figure 5. Gain and Noise Figure versus Collector Current

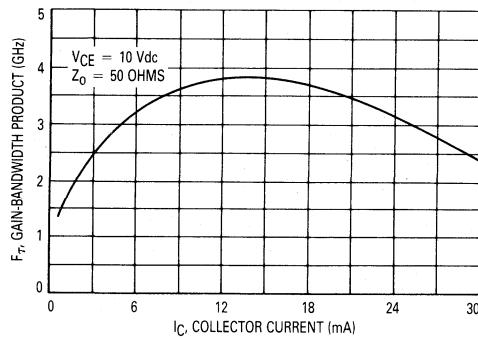


Figure 6. Gain-Bandwidth Product versus Collector Current

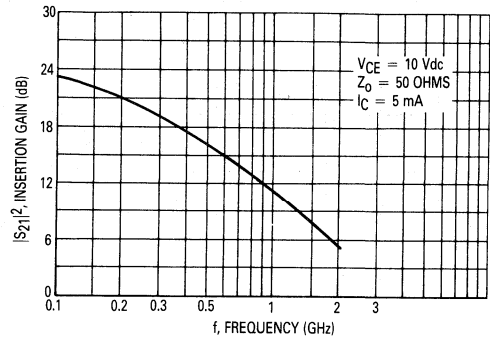


Figure 7. Insertion Gain versus Frequency

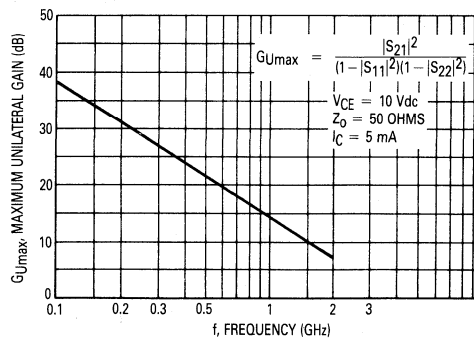


Figure 8. Maximum Unilateral Gain versus Frequency

COMMON EMITTER S-PARAMETERS

V _{CE} (V _{dc})	I _C (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
5	5	100	0.85	-41	13.64	153	0.03	65	0.93	-17
		200	0.78	-76	10.77	134	0.05	54	0.80	-29
		500	0.71	-131	6.10	102	0.08	35	0.55	-42
		1000	0.66	-169	3.22	77	0.08	33	0.45	-48
		2000	0.60	152	1.65	47	0.11	46	0.47	-63
	10	100	0.72	-59	20.01	145	0.03	62	0.87	-23
		200	0.70	-100	14.31	123	0.04	49	0.67	-36
		500	0.66	-150	7.03	94	0.06	38	0.44	-43
		1000	0.63	179	3.57	73	0.07	45	0.37	-46
		2000	0.58	147	1.79	46	0.11	57	0.41	-60
	15	100	0.65	-75	23.44	138	0.02	57	0.81	-27
		200	0.66	-118	15.56	116	0.04	46	0.59	-38
		500	0.65	-159	7.10	90	0.05	42	0.40	-40
		1000	0.63	174	3.57	71	0.06	52	0.35	-43
		2000	0.59	144	1.77	45	0.11	62	0.40	-58
	20	100	0.61	-89	24.32	133	0.02	51	0.77	-28
		200	0.66	-130	15.11	111	0.03	43	0.55	-35
		500	0.66	-166	6.68	88	0.04	46	0.41	-34
		1000	0.65	171	3.32	69	0.06	56	0.39	-39
		2000	0.61	143	1.65	43	0.10	65	0.44	-56
	30	100	0.63	-132	13.18	118	0.02	47	0.72	-15
		200	0.68	-157	7.07	104	0.02	44	0.66	-16
		500	0.69	-177	3.23	90	0.03	55	0.62	-24
		1000	0.70	165	1.78	71	0.05	65	0.59	-38
		2000	0.66	138	0.93	42	0.09	79	0.62	-62
10	5	100	0.85	-38	13.67	155	0.03	70	0.93	-14
		200	0.80	-71	10.97	136	0.05	56	0.83	-24
		500	0.70	-126	6.35	104	0.07	37	0.60	-35
		1000	0.65	-166	3.39	78	0.07	36	0.51	-40
		2000	0.58	154	1.74	48	0.10	50	0.54	-55
	10	100	0.75	-55	20.12	147	0.02	66	0.88	-19
		200	0.71	-94	14.60	125	0.04	50	0.72	-30
		500	0.65	-145	7.33	96	0.05	39	0.50	-35
		1000	0.62	-177	3.74	74	0.06	46	0.45	-38
		2000	0.57	149	1.88	47	0.10	60	0.49	-53
	15	100	0.68	-68	23.53	140	0.02	61	0.85	-22
		200	0.67	-110	15.90	119	0.03	49	0.65	-31
		500	0.64	-155	7.45	92	0.04	42	0.47	-32
		1000	0.62	177	3.74	71	0.06	53	0.44	-35
		2000	0.58	146	1.90	45	0.09	65	0.50	-51
	20	100	0.64	-79	24.77	135	0.02	56	0.81	-23
		200	0.64	-122	15.81	114	0.03	46	0.62	-29
		500	0.64	-161	7.10	89	0.04	46	0.48	-28
		1000	0.62	174	3.53	70	0.05	56	0.46	-33
		2000	0.59	145	1.75	44	0.09	68	0.53	-50
	30	100	0.61	-114	16.25	123	0.01	48	0.79	-15
		200	0.63	-147	9.10	107	0.02	49	0.71	-15
		500	0.65	-172	4.22	90	0.03	53	0.66	-22
		1000	0.66	168	2.27	71	0.05	63	0.63	-33
		2000	0.63	140	1.15	41	0.08	79	0.67	-53

The RF Line
NPN Silicon
High-Frequency Transistors

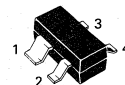
... designed primarily for use in low power amplifiers to 1 GHz. Ideal for pagers and other battery operated systems where low power consumption is critical.

- Low Power Consumption Characterized for $I_E = 0.1$ to 1 mA
- High Current-Gain-Bandwidth Product — $f_T = 5$ GHz (Typ) @ $I_C = 1$ mAdc
- Low Noise Figure and High Power Gain @ $f = 1$ GHz — NF(matched) = 2.5 dB (Typ) & GNF(matched) = 12.5 dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance
Lower Package Parasitics
High Gain
- Available In Both Standard Profile (MRF9331) and Low Profile (MRF9331L)
- Tape and Reel Packaging Options

MRF9331
BF432*
MRF9331L
BF432L*

*European Part Numbers

SURFACE MOUNTED
HIGH FREQUENCY
TRANSISTORS
NPN SILICON



CASE 318A-04, STYLE 1
SOT-143

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	8	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	2	Vdc
Collector-Current — Continuous	I_C	1	mAdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 1	mW mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	500	$^\circ\text{C/W}$

DEVICE MARKING

MRF9331,L = 05

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 0.1$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	8	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.01$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Leakage Current ($V_{EB} = 2$ Vdc, $I_C = 0$)	I_{EBO}	—	—	0.1	mAdc
Collector Cutoff Current ($V_{CB} = 5$ Vdc, $I_E = 0$)	I_{CBO}	—	—	50	nAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 0.5$ mAdc, $V_{CE} = 1$ Vdc)	h_{FE}	30	80	200	—
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(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Current-Gain-Bandwidth Product ($I_C = 1\text{ mA dc}$, $V_{CE} = 1\text{ V dc}$, $f = 1\text{ GHz}$)	Figure 2	f_T	3.5	5	—	GHz
Collector-Base Capacitance ($V_{CB} = 1\text{ V dc}$, $I_E = 0$, $f = 1\text{ MHz}$)	Figure 1	C_{cb}	—	0.21	0.3	pF
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure ($V_{CE} = 1\text{ V dc}$, $I_C = 0.5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 5, 3	GN_{Fmin}	—	12.5	—	dB
Noise Figure ($V_{CE} = 1\text{ V dc}$, $I_C = 0.5\text{ mA}$, $f = 1\text{ GHz}$)	Figure 5, 3	NF_{min}	—	2.5	—	dB

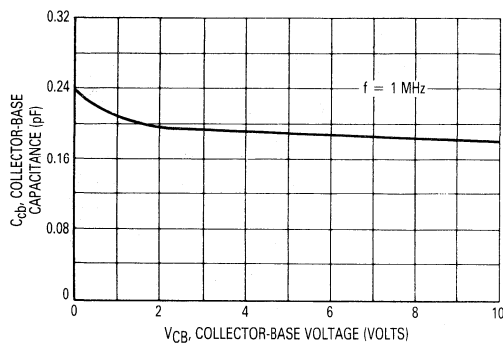


Figure 1. Collector-Base Capacitance versus Collector-Base Voltage

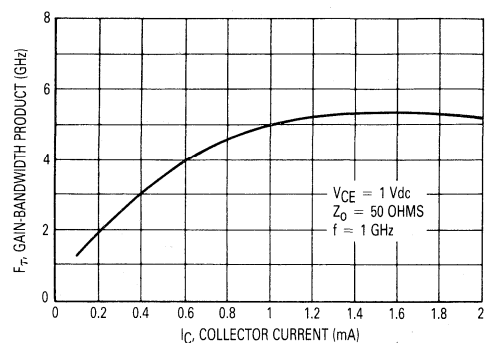


Figure 2. Current Gain-Bandwidth Product versus Collector Current

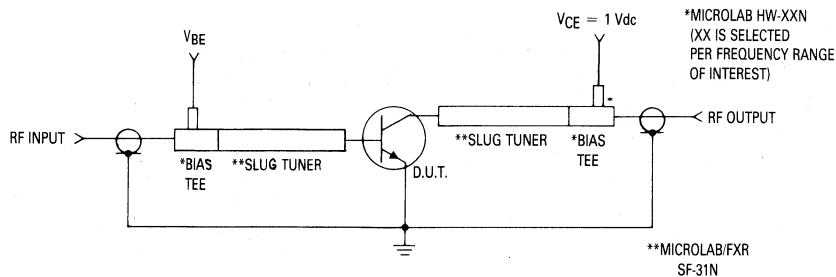


Figure 3. Functional Circuit Schematic

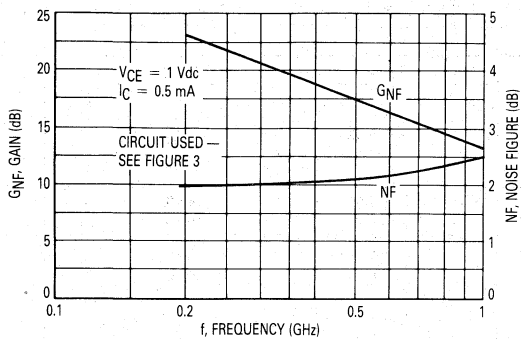


Figure 4. Gain and Noise Figure versus Frequency

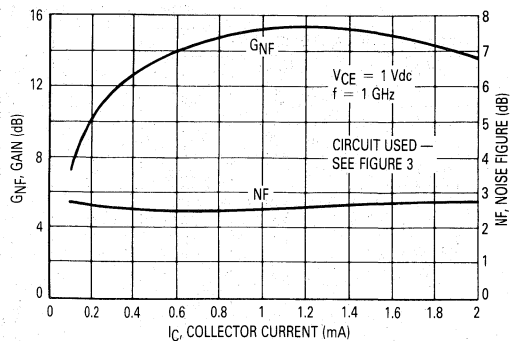


Figure 5. Gain and Noise Figure versus Collector Current

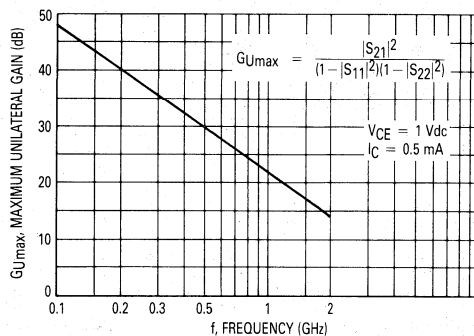


Figure 6. Maximum Unilateral Gain versus Frequency

COMMON EMITTER S-PARAMETERS

VCE (Vdc)	IC (mA)	f (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
1	0.1	100	0.99	-1	0.35	174	0.01	87	1	-1
		200	1	-3	0.35	171	0.03	86	1	-4
		500	0.97	-9	0.34	156	0.07	81	1	-9
		1000	0.98	-19	0.38	134	0.13	72	1	-21
		2000	0.98	-36	0.45	103	0.22	59	1	-38
	0.25	100	0.99	-1	0.77	175	0.01	86	1	-1
		200	1	-4	0.77	173	0.03	86	1	-4
		500	0.96	-11	0.73	160	0.06	79	0.99	-11
		1000	0.96	-23	0.75	140	0.13	70	0.98	-23
		2000	0.94	-42	0.77	110	0.21	56	0.93	-42
	0.5	100	0.99	-2	1.43	174	0.01	86	1	-1
		200	0.99	-5	1.42	172	0.03	84	1	-5
		500	0.95	-13	1.33	158	0.06	77	0.99	-12
		1000	0.92	-28	1.3	137	0.13	67	0.95	-25
		2000	0.83	-51	1.2	107	0.19	54	0.91	-43

COMMON EMITTER S-PARAMETERS (Continued)

VCE (Vdc)	IC (mA)	f (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
			|S ₁₁|	∠φ	|S ₂₁|	∠φ	|S ₁₂|	∠φ	|S ₂₂|	∠φ
1	1	100	0.97	-3	2.68	173	0.01	85	1	-2
		200	0.97	-8	2.68	169	0.03	83	1	-6
		500	0.91	-19	2.42	152	0.06	74	0.96	-15
		1000	0.82	-37	2.22	128	0.11	62	0.89	-29
		2000	0.63	-59	1.74	97	0.17	53	0.8	-46
	2	100	0.93	-6	4.55	169	0.01	84	0.99	-4
		200	0.92	-13	4.3	163	0.03	81	0.98	-9
		500	0.81	-29	3.8	142	0.06	69	0.91	-19
		1000	0.62	-52	3.1	115	0.1	59	0.81	-31
		2000	0.4	-66	2	85	0.14	55	0.75	-44
3	0.1	100	0.99	-1	0.34	175	0.01	88	1	-1
		200	1	-3	0.34	172	0.03	86	1	-3
		500	0.99	-8	0.32	157	0.06	81	1	-9
		1000	0.99	-18	0.36	137	0.11	73	1	-20
		2000	1	-34	0.43	107	0.2	61	1	-37
	0.25	100	0.99	-1	0.76	175	0.01	86	1	-1
		200	1	-4	0.76	173	0.03	86	1	-4
		500	0.98	-10	0.72	161	0.06	80	1	-10
		1000	0.98	-21	0.75	143	0.11	72	0.99	-22
		2000	0.97	-40	0.75	113	0.19	59	0.98	-39
	0.5	100	0.99	-2	1.4	175	0.01	86	1	-1
		200	0.99	-5	1.42	172	0.03	84	1	-4
		500	0.96	-12	1.3	159	0.06	78	0.99	-11
		1000	0.93	-25	1.3	141	0.11	68	0.96	-23
		2000	0.87	-47	1.2	111	0.18	57	0.93	-41
	1	100	0.97	-3	2.67	174	0.01	85	1	-2
		200	0.98	-7	2.67	170	0.02	84	1	-6
		500	0.93	-17	2.42	154	0.06	76	0.97	-14
		1000	0.84	-34	2.29	133	0.1	65	0.91	-26
		2000	0.67	-55	1.82	101	0.16	56	0.85	-43
	2	100	0.95	-5	4.64	172	0.01	85	1	-3
		200	0.94	-10	4.62	166	0.02	81	0.99	-8
		500	0.85	-25	4	147	0.05	72	0.94	-17
		1000	0.69	-44	3.4	122	0.09	63	0.84	-29
		2000	0.48	-61	2.3	91	0.13	57	0.78	-42
5	0.1	100	1	0	0.36	175	0.01	85	1	-1
		200	1	-3	0.34	172	0.02	87	1	-3
		500	0.99	-8	0.32	158	0.06	82	1	-9
		1000	1	-17	0.36	138	0.11	74	1	-19
		2000	0.94	-35	0.42	108	0.2	63	1	-36
	0.25	100	1	-1	0.76	176	0.01	86	1	-1
		200	1	-3	0.76	174	0.02	86	1	-4
		500	0.97	-9	0.71	161	0.06	80	1	-10
		1000	0.97	-20	0.74	143	0.11	73	0.99	-21
		2000	0.97	-38	0.75	115	0.18	61	0.99	-38
	0.5	100	0.99	-1	1.4	175	0.01	86	1	-1
		200	1	-5	1.41	173	0.02	85	1	-4
		500	0.98	-12	1.3	159	0.06	79	0.99	-11
		1000	0.93	-25	1.3	141	0.1	70	0.97	-23
		2000	0.87	-45	1.2	111	0.17	58	0.94	-40
	1	100	0.98	-3	2.7	174	0.01	86	1	-2
		200	0.98	-7	2.7	170	0.02	84	1	-5
		500	0.93	-17	2.42	155	0.5	76	0.97	-13
		1000	0.85	-33	2.3	134	0.09	66	0.92	-26
		2000	0.67	-55	2	103	0.15	57	0.85	-42
	2	100	0.95	-4	4.6	172	0.01	86	1	-3
		200	0.94	-10	4.6	166	0.02	83	1	-7
		500	0.86	-24	3.9	148	0.5	73	0.94	-16
		1000	0.7	-43	3.4	123	0.9	64	0.86	-28
		2000	0.5	-60	2.3	92	0.13	59	0.8	-40

The RF Line

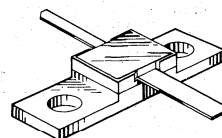
Microwave Power Transistor

... designed for CW and long pulsed common base amplifier applications, such as JTIDS and Mode S, in the 0.96 to 1.215 GHz frequency range at high overall duty cycles.

- Guaranteed Performance @ 1.215 GHz, 28 Vdc
 Output Power = 5 Watts CW
 Minimum Gain = 8.5 dB, 10.3 dB (Typ)
- RF Performance Curves given for 28 Vdc and 36 Vdc Operation
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

MRF10005

**MICROWAVE POWER
 TRANSISTOR
 NPN SILICON
 5 WATTS
 960-1215 MHz**



CASE 336E-02

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	55	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous (1)	I_C	1.25	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (1) Derate above 25°C	P_D	25 143	Watts mW/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$
Junction Temperature	T_J	200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	7	$^\circ\text{C/W}$

- (1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
 (2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I _C = 25 mA _{dc} , V _{BE} = 0)	V _{(BR)CES}	55	—	—	V _{dc}
Collector-Base Breakdown Voltage (I _C = 25 mA _{dc} , I _E = 0)	V _{(BR)CBO}	55	—	—	V _{dc}
Emitter-Base Breakdown Voltage (I _E = 0.5 mA _{dc} , I _C = 0)	V _{(BR)EBO}	3.5	—	—	V _{dc}
Collector Cutoff Current (V _{CB} = 28 V _{dc} , I _E = 0)	I _{CBO}	—	—	1	mA _{dc}

ON CHARACTERISTICS

DC Current Gain (I _C = 500 mA _{dc} , V _{CE} = 5 V _{dc})	h _{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance (V _{CB} = 28 V _{dc} , I _E = 0, f = 1 MHz)	C _{ob}	—	7	10	pF
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FUNCTIONAL TESTS

Common-Base Amplifier Power Gain (V _{CC} = 28 V _{dc} , P _{out} = 5 W, f = 1215 MHz)	G _{PB}	8.5	10.3	—	dB
Collector Efficiency (V _{CC} = 28 V _{dc} , P _{out} = 5 W, f = 1215 MHz)	η	45	55	—	%
Load Mismatch (V _{CC} = 28 V _{dc} , P _{out} = 5 W, f = 1215 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			

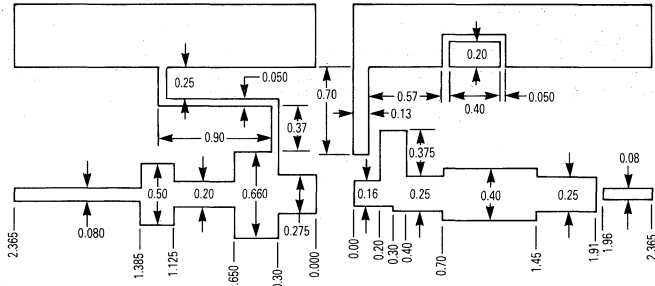
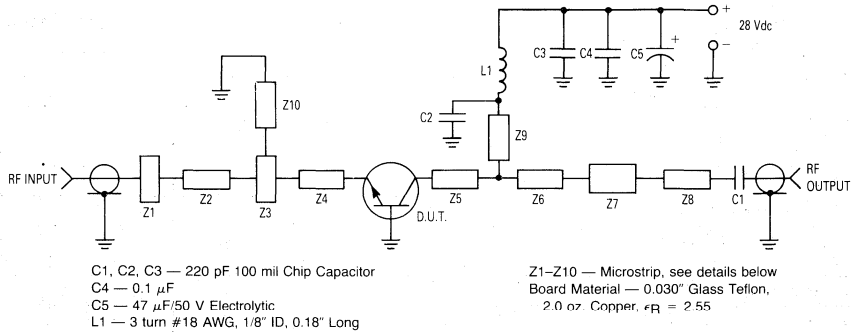


Figure 1. Test Circuit

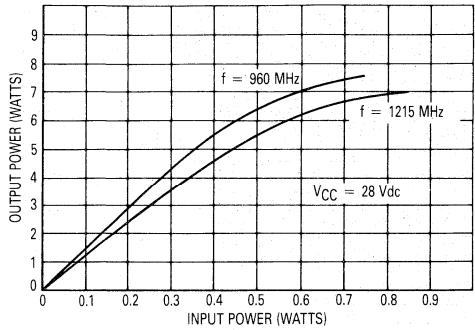


Figure 2. Output Power versus Input Power

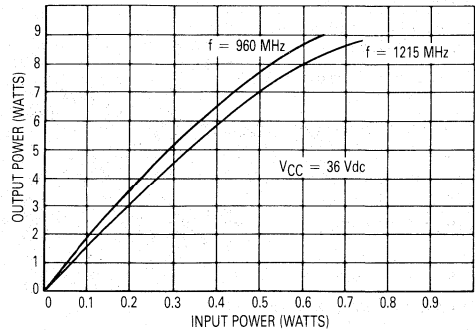
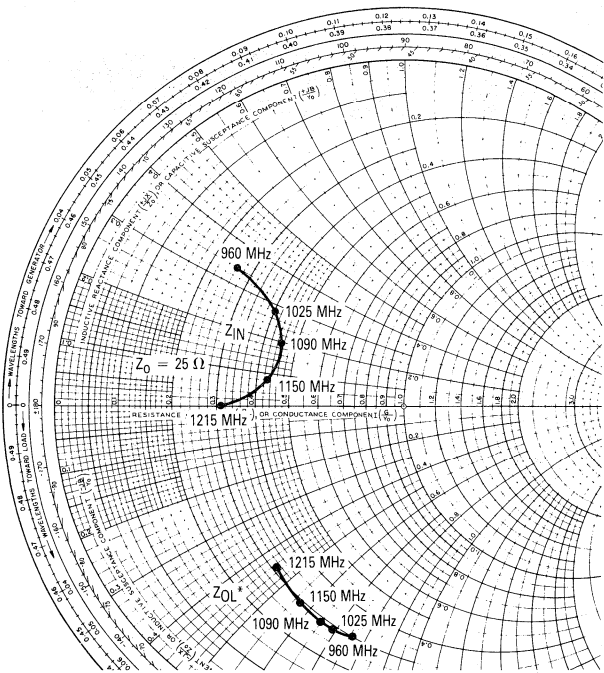


Figure 3. Output Power versus Input Power



$P_{OUT} = 5\text{ W}$ $V_{CC} = 28\text{ V}$

f MHz	Z_{IN} OHMS	Z_{OL}^* OHMS
960	$6.5 + j8.5$	$7.4 - j18.9$
1025	$10.0 + j7.0$	$7.2 - j17.4$
1090	$11.2 + j4.9$	$7.1 - j16.3$
1150	$10.8 + j2.0$	$7.15 - j14.3$
1215	$7.8 + j0.0$	$7.8 - j11.2$

* Z_{OL} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 4. Series Equivalent Input/Output Impedances

2

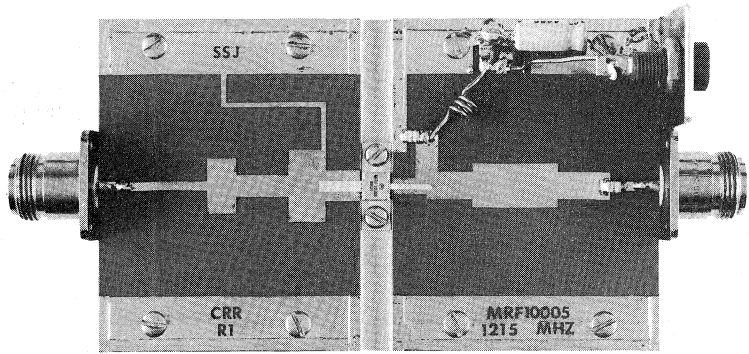
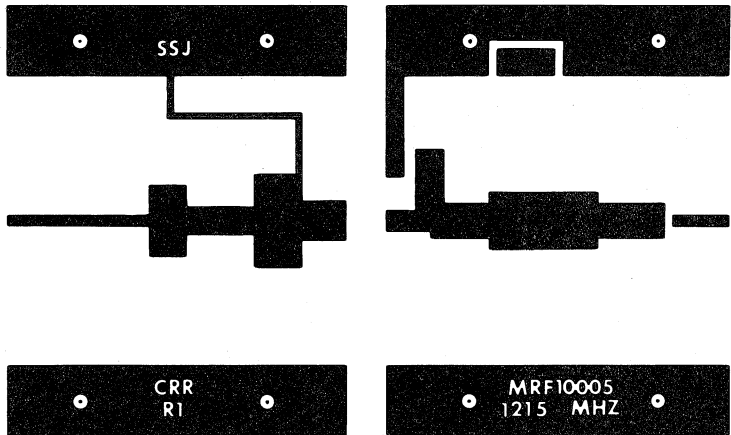


Figure 5. Test Amplifier



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 6. Printed Circuit Board Layout

The RF Line

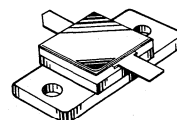
**Microwave Long Pulse
Power Transistor**

... designed for 960 to 1215 MHz long pulse common base amplifier applications such as JTIDS and Mode S transmitters.

- Guaranteed Performance @ 1.215 GHz, 36 Vdc
Output Power = 30 Watts Peak
Minimum Gain = 9.5 dB, 11.5 dB (Typ)
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

MRF10030

**MICROWAVE POWER
TRANSISTOR
NPN SILICON
30 WATTS PEAK
960-1215 MHz**



CASE 376A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CES}	55	Vdc
Collector-Base Voltage (1)	V _{CBO}	55	Vdc
Emitter-Base Voltage	V _{EBO}	3.5	Vdc
Collector-Current — Continuous (1)	I _C	5	Adc
Total Device Dissipation @ T _C = 25°C (1), (2) Derate above 25°C	P _D	58.3 333	Watts mW/°C
Storage Temperature Range	T _{stg}	-65 to +200	°C
Junction Temperature	T _J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	R _{θJC}	3	°C/W

(1) Under pulse RF operating conditions.

(2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as pulsed RF amplifiers.

(3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	55	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 36\text{ Vdc}$, $I_E = 0$)	I_{CBO}	—	—	2	mA

ON CHARACTERISTICS

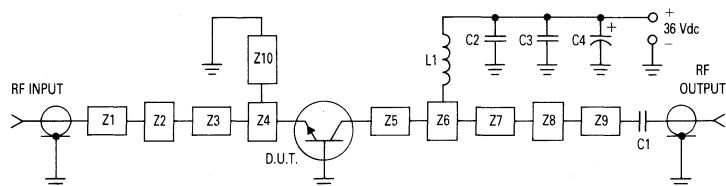
DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5\text{ Vdc}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 36\text{ Vdc}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	21	30	pF
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FUNCTIONAL TESTS (10 μs Pulses @ 50% duty cycle for 3.5 ms; overall duty cycle – 25%)

Common-Base Amplifier Power Gain ($V_{CC} = 36\text{ Vdc}$, $P_{out} = 30\text{ W Peak}$, $f = 1215\text{ MHz}$)	G_{PB}	9.5	11.5	—	dB
Collector Efficiency ($V_{CC} = 36\text{ Vdc}$, $P_{out} = 30\text{ W Peak}$, $f = 1215\text{ MHz}$)	η	45	55	—	%
Load Mismatch ($V_{CC} = 36\text{ Vdc}$, $P_{out} = 30\text{ W Peak}$, $f = 1215\text{ MHz}$, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			

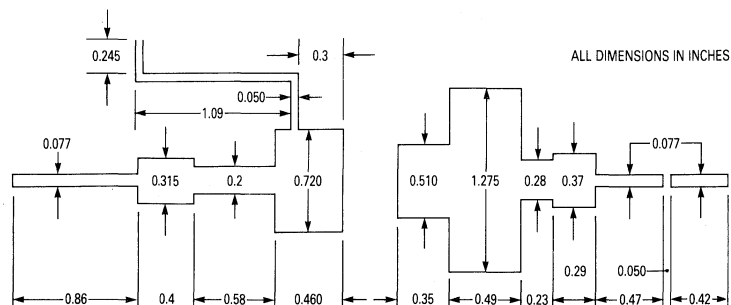


C1, C2 — 220 pF 100 mil Chip Capacitor

C3 — 0.1 μF C4 — 10 $\mu\text{F}/75\text{ V}$ Electrolytic

L1 — 3 Turns #18 AWG, 1/8" ID

Z1–Z10 — Microstrip, see details below

Board Material — 0.030" Glass Teflon,
2.0 oz. Copper, $\epsilon_R = 2.55$ **Figure 1. Test Circuit**

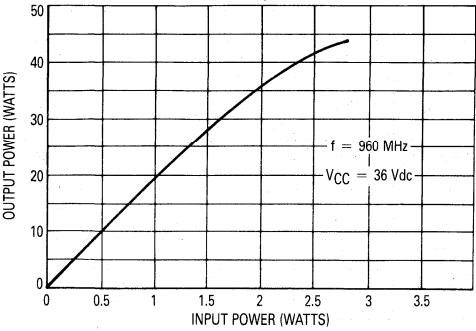


Figure 2. Output Power versus Input Power

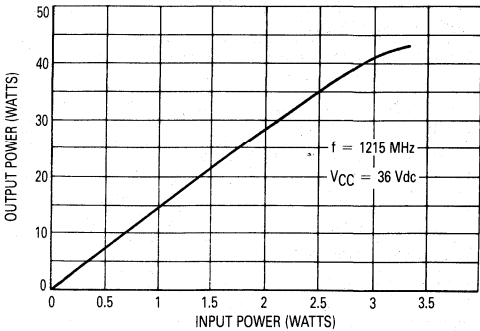


Figure 3. Output Power versus Input Power

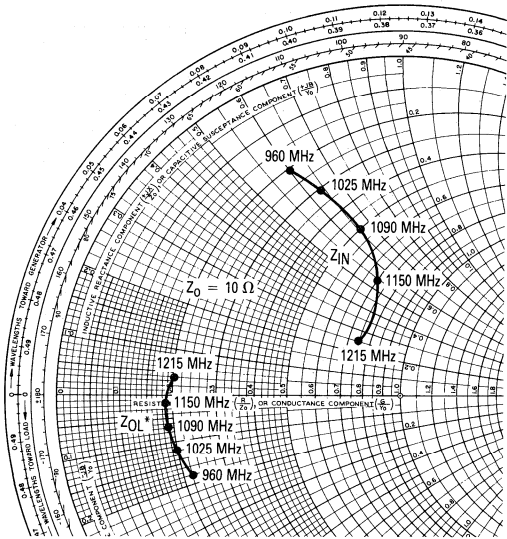


Figure 4. Series Equivalent Input/Output Impedances

$P_{OUT} = 30 \text{ W pk}$ $V_{CC} = 36 \text{ V}$

f MHz	Z_{IN} OHMS	Z_{OUT}^* OHMS
960	$2.1 + j6.0$	$2.2 - j1.8$
1025	$3.1 + j6.4$	$2.0 - j1.2$
1090	$5.0 + j6.55$	$1.9 - j0.7$
1150	$7.0 + j5.4$	$1.85 - j0.2$
1215	$7.5 + j2.5$	$2.0 + j0.4$

* Z_{OUT} = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

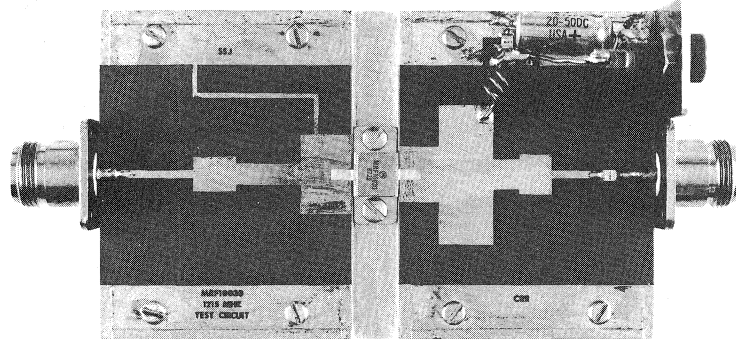
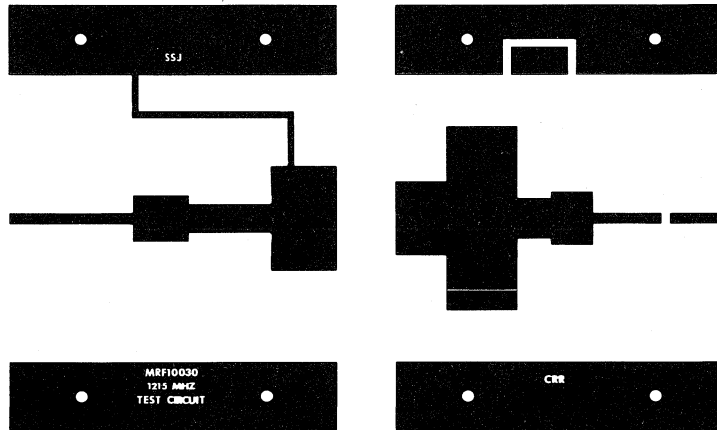


Figure 5. Test Amplifier



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 6. Printed Circuit Board Layout

The RF Line **NPN Silicon** **High Frequency Transistor**

... designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

MRFQ17

DIE SOURCE SAME AS
BFQ17

SURFACE MOUNT
RF TRANSISTOR
NPN SILICON



CASE 751-03
SO-8

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	V
Collector-Base Voltage	V_{CBO}	40	V
Emitter-Base Voltage	V_{EBO}	2	V
Collector Current — Continuous	I_C	300	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$)	$V_{(BR)CEO}$	25	—	—	V
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$)	$V_{(BR)CBO}$	40	—	—	V
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{A}$)	$V_{(BR)EBO}$	2	—	—	V
Collector Cutoff Current ($V_{CB} = 20\text{ V}$)	I_{CBO}	—	—	100	nA
Emitter Cutoff Current ($V_{EB} = 1\text{ V}$)	I_{EBO}	—	—	100	nA

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 5\text{ V}$) ($I_C = 150\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	25	—	200	—
		25	—	200	—
Collector-Emitter Saturation Voltage ($I_C = 100\text{ mA}$, $I_B = 10\text{ mA}$)	$V_{CE(sat)}$	—	—	0.5	V

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 50\text{ mA}$, $V_{CE} = 12.5\text{ V}$, $f = 500\text{ MHz}$)	f_T	—	2250	—	MHz
Insertion Gain ($V_{CE} = 12.5\text{ V}$, $I_C = 50\text{ mA}$, $f = 500\text{ MHz}$)	$|S_{21}|^2$	10	12.2	—	dB

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle\phi$	$|S_{21}|$	$\angle\phi$	$|S_{12}|$	$\angle\phi$	$|S_{22}|$	$\angle\phi$
12.5	50	10	0.32	-72	38.2	165	0.005	47	0.97	-13
		20	0.36	-103	37.8	151	0.007	48	0.88	-23
		50	0.60	-139	33.0	124	0.013	40	0.62	-42
		75	0.66	-152	25.0	112	0.014	36	0.49	-47
		100	0.69	-159	19.6	105	0.016	38	0.43	-49
		200	0.72	-174	10.3	91	0.021	47	0.32	-51
		500	0.72	168	4.1	68	0.040	65	0.37	-70
		750	0.70	157	2.8	57	0.059	72	0.43	-83
		1000	0.69	146	2.1	45	0.081	76	0.47	-95

The RF Line **NPN Silicon** **High Frequency Transistor**

... designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

MRFQ19

DIE SOURCE SAME AS
BFQ19

SURFACE MOUNT
RF TRANSISTOR
NPN SILICON



CASE 751-03
SO-8

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	V
Collector-Base Voltage	V_{CBO}	20	V
Emitter-Base Voltage	V_{EBO}	3	V
Collector Current — Continuous	I_C	150	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$)	$V_{(BR)CEO}$	15	—	—	V
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{A}$)	$V_{(BR)CBO}$	20	—	—	V
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{A}$)	$V_{(BR)EBO}$	3	—	—	V
Emitter Cutoff Current ($V_{EB} = 1\text{ V}$)	I_{EBO}	—	—	100	nA
Collector Cutoff Current ($V_{CB} = 10\text{ V}$)	I_{CBO}	—	—	100	nA

(continued)

ELECTRICAL CHARACTERISTICS — continued ($T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
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ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ V}$) ($I_C = 75\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	25	—	200	—
		25	—	200	—
Collector-Emitter Saturation Voltage ($I_C = 100\text{ mA}$, $I_B = 10\text{ mA}$)	$V_{CE(sat)}$	—	—	0.2	V

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ V}$, $f = 500\text{ MHz}$) ($I_C = 75\text{ mA}$, $V_{CE} = 10\text{ V}$, $f = 500\text{ MHz}$)	f_T	—	—	5300	—
		—	—	5500	—
Insertion Gain ($V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$, $f = 500\text{ MHz}$)	$|S_{21}|^2$	13	14.6	—	dB
Noise Figure ($V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$, $f = 500\text{ MHz}$)	NF	—	3.5	—	dB

TYPICAL COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$|S_{11}|$	$\angle\phi$	$|S_{21}|$	$\angle\phi$	$|S_{12}|$	$\angle\phi$	$|S_{22}|$	$\angle\phi$
10	50	50	0.46	-149	41.5	128	0.013	47	0.66	-63
		100	0.55	-164	29.8	110	0.02	51	0.44	-90
		200	0.60	-177	13.2	95	0.04	58	0.29	-112
		500	0.60	165	5.4	76	0.07	73	0.27	-146
		750	0.57	158	3.6	71	0.10	62	0.30	-100
		1000	0.55	143	2.6	59	0.13	59	0.43	-144
		1300	0.52	133	2.0	48	0.16	49	0.44	-136

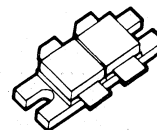
The RF Line UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 100 to 500 MHz frequency range.

- Designed for Class AB Linear Power Amplifiers
- Specified 28 Volt, 500 MHz Characteristics:
Output Power — 75 Watts
Power Gain — 7.5 dB Min, Class AB
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Push-Pull Package Configuration

MRT0105-75

**7.5 dB
100 to 500 MHz
75 WATTS
BROADBAND
UHF POWER
TRANSISTOR**



**HLP-50
CASE 390-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	58	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous (Note 1)	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (Note 1)

Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	58	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CBO}$	58	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	I_{CBO}	—	—	20	mAdc

ON CHARACTERISTICS (Note 1)

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	90	—
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DYNAMIC CHARACTERISTICS (Note 1)

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	75	pF
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Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 75\text{ W}$, $f = 500\text{ MHz}$, $I_{CQ} = 2 \times 120\text{ mA}$)	GPE	7.5	9	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $I_{CQ} = 2 \times 120\text{ mA}$, $P_{out} = 75\text{ W}$, $f = 100\text{ MHz}$, Load VSWR = 5:1, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28\text{ V}$, $f = 500\text{ MHz}$, $I_{CQ} = 2 \times 120\text{ mA}$)	P_{sat}	75	—	—	W

Note 2. Both transistor chips operating in push-pull amplifier.

TYPICAL CHARACTERISTICS

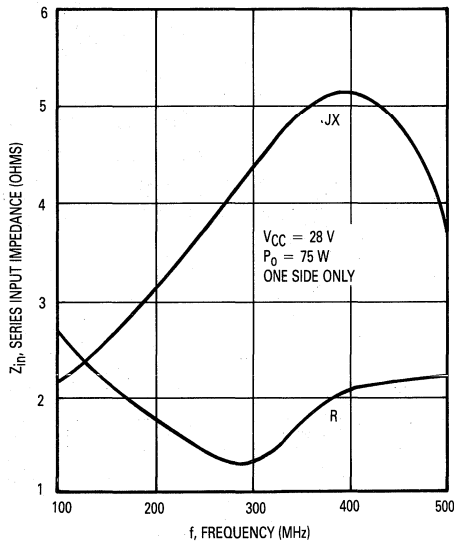


Figure 1. Input Impedance versus Frequency

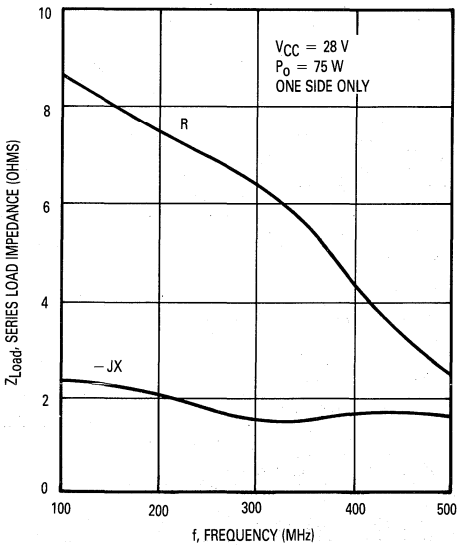


Figure 2. Load Impedance versus Frequency

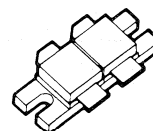
The RF Line UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 100 to 500 MHz frequency range.

- Designed for Class AB Linear Power Amplifiers
- Specified 28 Volt, 500 MHz Characteristics:
Output Power — 75 Watts
Power Gain — 7 dB Min, Class AB
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Push-Pull Package Configuration

MRT0105-75V

**7 dB
100–500 MHz
75 WATTS
BROADBAND
UHF POWER
TRANSISTOR**



**HLP-50
CASE 390-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	58	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous (Note 1)	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	– 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (Note 1)

Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	58	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CBO}$	58	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	I_{CBO}	—	—	20	mAdc

ON CHARACTERISTICS (Note 1)

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	90	—
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DYNAMIC CHARACTERISTICS (Note 1)

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	75	pF
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Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 75\text{ W}$, $f = 500\text{ MHz}$, $I_{CQ} = 2 \times 120\text{ mA}$)	GPE	7	8	—	dB
Load Mismatch ($V_{CE} = 25\text{ V}$, $I_{CQ} = 2 \times 120\text{ mA}$, $P_{out} = 75\text{ W}$, $f = 100\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28\text{ V}$, $I_{CQ} = 2 \times 120\text{ mA}$, $f = 500\text{ MHz}$)	P _{sat}	85	—	—	W

Note 2. Both transistor chips operating in push-pull amplifier.

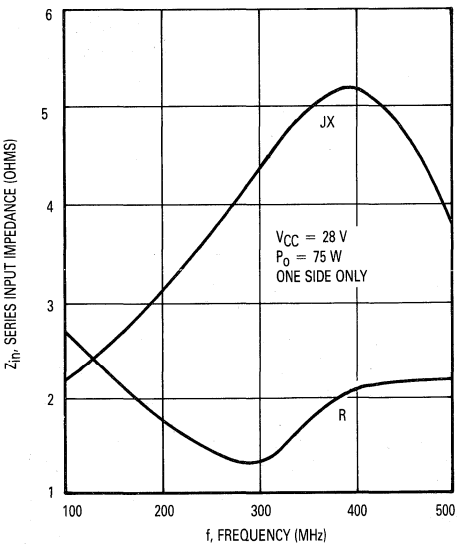


Figure 1. Input Impedance versus Frequency

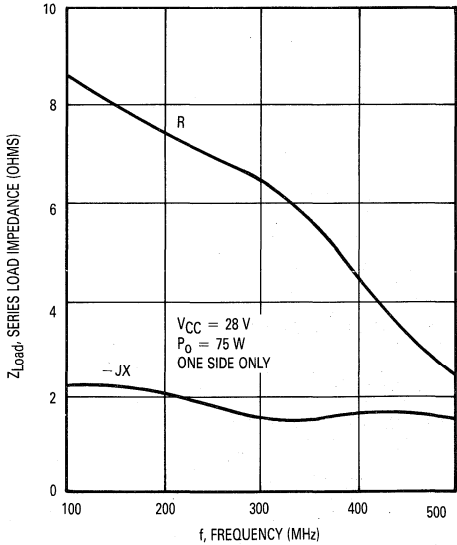


Figure 2. Load Impedance versus Frequency

The RF Line

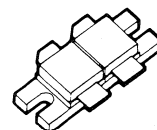
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 225 to 400 MHz frequency range.

- Designed for Class AB Linear Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
 Output Power — 110 Watts
 Power Gain — 7 dB Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Push-Pull Package Configuration

MRT0204-110V

7 dB
225-400 MHz
110 WATTS
BROADBAND
UHF POWER
TRANSISTOR



HLP-50
CASE 390-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous (Note 1)	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (Note 1)

Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 25$ mA, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 25$ V, $I_E = 0$)	I_{CBO}	—	—	10	mAdc

ON CHARACTERISTICS (Note 1)

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS (Note 1)

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	70	pF
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Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28 \text{ V}$, $P_{out} = 110 \text{ W}$, $f = 400 \text{ MHz}$, $I_{CQ} = 2 \times 120 \text{ mA}$)	G_{pE}	7	—	—	dB
Load Mismatch ($V_{CE} = 28 \text{ V}$, $P_{out} = 110 \text{ W}$, $f = 225 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28 \text{ V}$, $f = 400 \text{ MHz}$)	P_{sat}	125	—	—	W

Note 2. Both transistor chips operating in push-pull amplifier.

TYPICAL CHARACTERISTICS

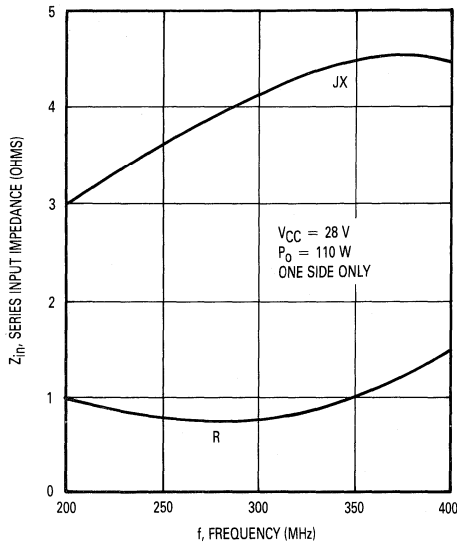


Figure 1. Input Impedance versus Frequency

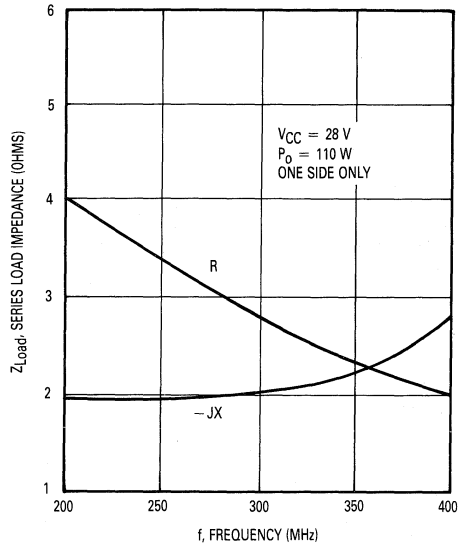


Figure 2. Load Impedance versus Frequency

PT4572A

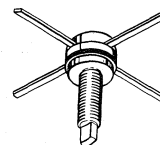
The RF Line

NPN Silicon **High Frequency Transistor**

... designed for broadband class A applications requiring high output, low distortion and low noise. Primarily used in intermediate or output stages of MATV or CATV amplifiers.

- Low Noise — 2.3 dB Typ @ $f = 300$ MHz
- High Output — P_{o1} dB = 27 dBm Typ @ $f = 500$ MHz
- Low Distortion — ITO = 45 dBm Typ @ $f = 500$ MHz

$I_C = 200$ mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



TO-117A
CASE 244D-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	200	mA
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5$ mA, $I_B = 0$)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	—	200	μA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	50	130	300	—
Collector-Emitter Saturation Voltage ($I_C = 100$ mA, $I_C/I_B = 2$)	$V_{CE(sat)}$	—	400	—	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 8$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	2.2	—	pF
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FUNCTIONAL TESTS

Noise Figure, Minimum ($V_{CE} = 8$ V, $I_C = 50$ mA, $f = 300$ MHz)	NF_{MIN}	—	2.3	—	dB
Cutoff Frequency ($V_{CE} = 14$ V, $I_C = 90$ mA)	f_T	—	2.5	—	GHz
Maximum Unilateral Gain ($V_{CE} = 14$ V, $I_C = 90$ mA, $f = 300$ MHz)	$G_{U_{MAX}}$	—	16	—	dB
Insertion Gain ($V_{CE} = 14$ V, $I_C = 90$ mA, $f = 300$ MHz)	$|S_{21}|^2$	—	14	—	dB
Output Power @ 1 dB Compression ($V_{CE} = 14$ V, $I_C = 90$ mA, $f = 500$ MHz)	P_{o1} dB	—	27	—	dBm
Third Order Intercept ($V_{CE} = 14$ V, $I_C = 90$ mA, $f = 500$ MHz)	ITO	—	45	—	dBm

TYPICAL CHARACTERISTICS

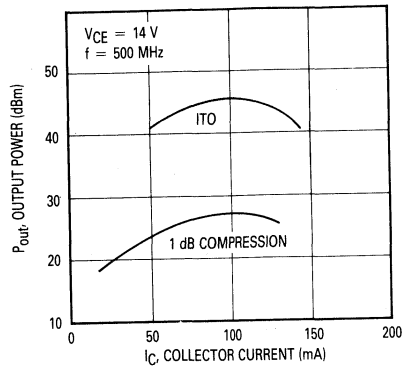


Figure 1. Third Order Intercept and 1 dB Compression

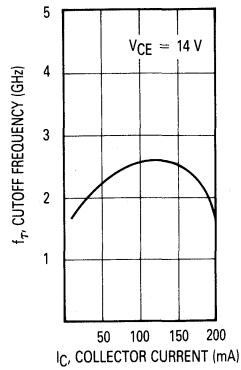


Figure 2. Gain-Bandwidth Product versus Collector Current

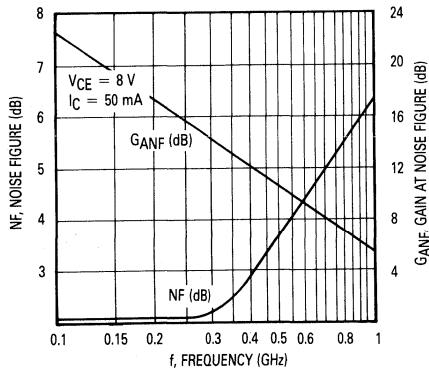
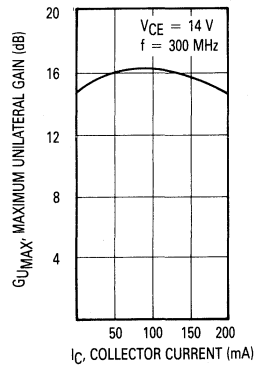


Figure 3. Noise Figure and Associated Gain versus Frequency

Figure 4. G_{UMAX} versus Collector Current

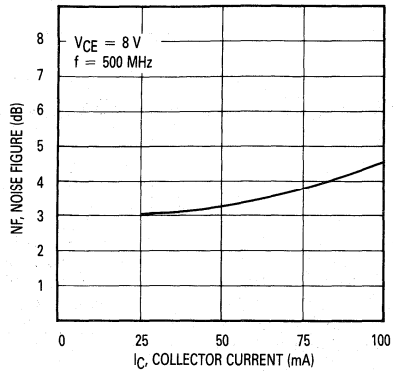


Figure 5. Noise Figure versus Collector Current

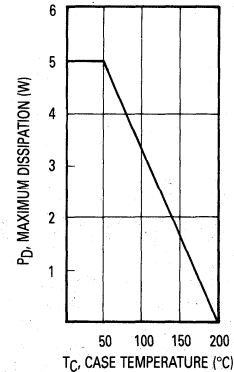


Figure 6. Dissipation versus Temperature

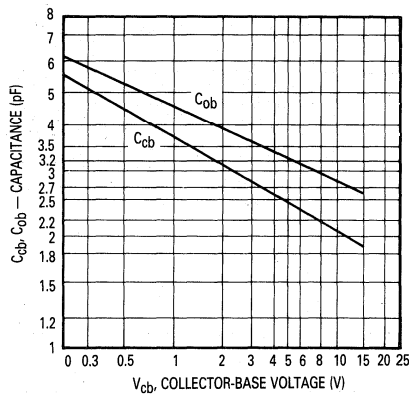


Figure 7. Junction Capacitance versus Voltage

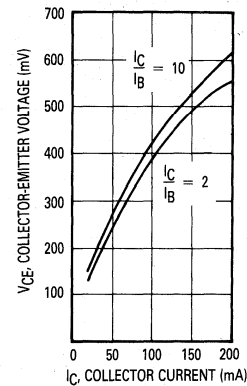


Figure 8. Collector Saturation Characteristics

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂		k
VCE = 8 V, IC = 50 mA									
100	-4.58	-172.6	22.07	96.2	-31.41	60.7	-16.48	-108.4	1.085
200	-4.47	169.5	17.14	84.5	-26.24	67.2	-20.29	-124.3	1.101
300	-4.29	156.2	13.79	74.2	-22.99	67.3	-18.02	-132.3	1.100
400	-4.32	146.8	11.42	65.4	-20.62	65.6	-18.23	-128.8	1.098
500	-4.30	136.9	9.43	57.6	-18.96	63.5	-16.01	-129.2	1.123
600	-4.04	128.1	7.90	49.7	-17.55	60.3	-15.84	-143.4	1.119
700	-4.20	121.3	6.47	43.5	-16.45	58.1	-14.73	-141.8	1.164
800	-4.10	113.1	5.23	36.5	-15.67	55.5	-12.53	-158.0	1.216
900	-4.00	105.5	4.08	30.9	-14.82	53.2	-12.23	-166.1	1.245
1000	-4.11	99.9	3.07	25.6	-14.12	51.4	-12.14	-170.1	1.295
VCE = 14 V, IC = 90 mA									
100	-4.49	-177.2	24.66	83.6	-32.32	66.1	-16.41	- 86.9	0.914
200	-4.61	167.1	17.94	75.5	-26.89	70.9	-19.88	- 92.7	1.066
300	-4.49	157.1	14.31	69.1	-23.68	71.1	-19.75	- 99.9	1.100
400	-4.25	147.5	11.78	62.7	-21.31	69.7	-18.35	-110.1	1.094
500	-4.16	138.0	9.76	56.5	-19.44	67.5	-17.36	-117.7	1.105
600	-4.01	130.3	8.14	50.2	-18.02	65.6	-15.80	-127.3	1.115
700	-3.97	123.5	6.80	44.7	-16.86	63.0	-14.36	-137.5	1.139
800	-4.07	115.2	5.43	38.9	-15.97	60.8	-13.31	-146.4	1.214
900	-3.99	107.8	4.23	34.1	-15.12	58.6	-12.54	-153.3	1.248
1000	-4.12	101.5	3.19	30.5	-14.40	57.2	-11.78	-161.1	1.312

Figure 9. Common Emitter S-Parameters

PT4579

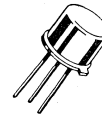
The RF Line

**NPN Silicon
High Frequency Transistor**

... designed for ultra-linear communications or instrumentation applications requiring high output and low noise. Low noise figure combined with high-output capability gives this device an exceptional dynamic range. Gold metallization is used to achieve the high reliability demanded by the most severe communications requirements. High gain makes this transistor ideal for broadband applications.

- Low Noise — 2.3 dB Typ @ $f = 300$ MHz
- High Output — $P_{O1\text{ dB}} = 26$ dBm Typ @ $f = 300$ MHz
- Low Distortion — $ITD = 46$ dBm Typ @ $f = 300$ MHz
- Gold Metallization

$I_C = 200$ mA
**HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



**TO-39
CASE 79-04, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	200	mA _{dc}
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25$ mA, $I_B = 0$)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ V, $I_E = 0$)	I_{CBO}	—	100	—	μ Adc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50$ mA, $V_{CE} = 5$ V)	h_{FE}	50	150	300	—
Collector-Emitter Saturation Voltage ($I_C = 100$ mA, $I_C/I_B = 2$)	$V_{CE(sat)}$	—	400	—	mV

DYNAMIC CHARACTERISTICS

Collector-Base Capacitance ($V_{CB} = 8$ V, $I_E = 0$, $f = 1$ MHz)	C_{cb}	—	2.5	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum ($V_{CE} = 8 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 300 \text{ MHz}$)	NF_{MIN}	—	2.3	—	dB
Cutoff Frequency ($V_{CE} = 14 \text{ V}$, $I_C = 90 \text{ mA}$)	f_T	—	2.5	—	GHz
Maximum Unilateral Gain ($V_{CE} = 14 \text{ V}$, $I_C = 90 \text{ mA}$, $f = 300 \text{ MHz}$)	G_{UMAX}	—	13.5	—	dB
Insertion Gain ($V_{CE} = 14 \text{ V}$, $I_C = 90 \text{ mA}$, $f = 300 \text{ MHz}$)	$|S_{21}|^2$	—	12	—	dB
Output Power @ 1 dB Compression ($V_{CE} = 14 \text{ V}$, $I_C = 90 \text{ mA}$, $f = 300 \text{ MHz}$)	$P_{O1 \text{ dB}}$	—	26	—	dBm
Third Order Intercept ($V_{CE} = 14 \text{ V}$, $I_C = 90 \text{ mA}$, $f = 300 \text{ MHz}$)	ITO	—	46	—	dBm

TYPICAL CHARACTERISTICS

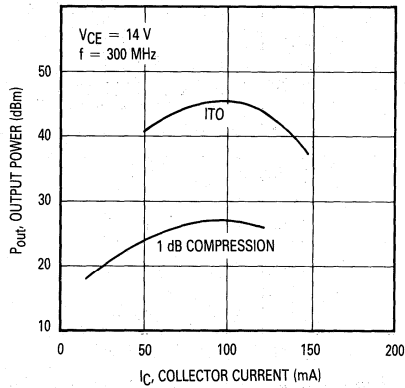


Figure 1. Third Order Intercept and 1 dB Compression

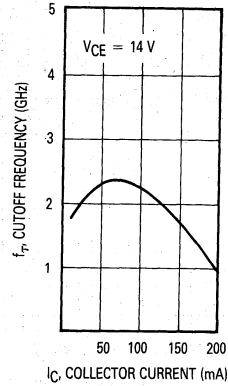


Figure 2. Gain-Bandwidth Product versus Collector Current

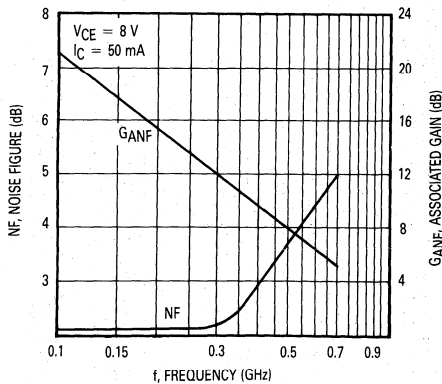


Figure 3. Noise Figure and Associated Gain versus Frequency

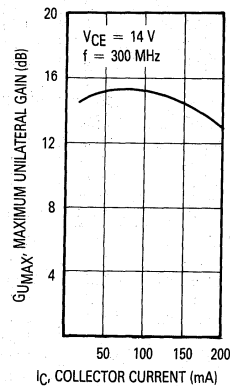


Figure 4. G_{UMAX} versus Collector Current

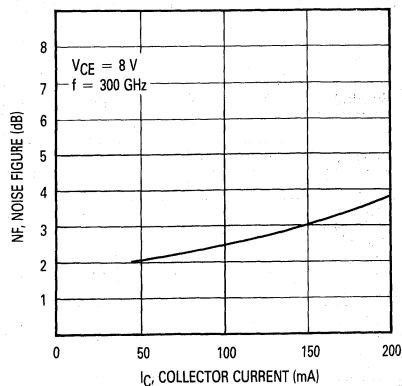


Figure 5. Noise Figure versus Collector Current

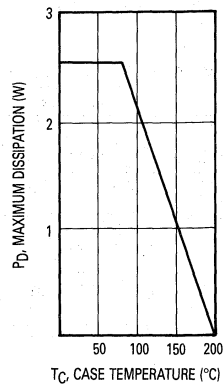


Figure 6. Dissipation versus Temperature

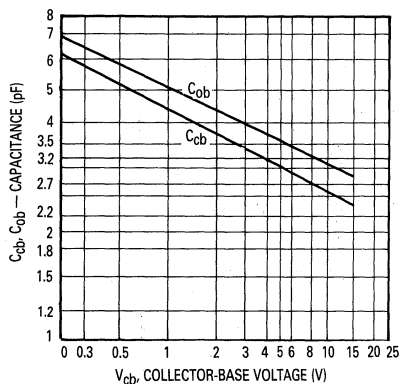


Figure 7. Junction Capacitance versus Voltage

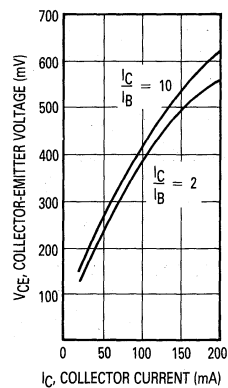


Figure 8. Collector Saturation Characteristics

Frequency (MHz)	S ₁₁		S ₂₁		S ₁₂		S ₂₂		k
VCE = 8 V, IC = 50 mA									
100	-5.90	-170.7	19.47	96.2	-26.71	66.7	-15.48	-113.1	1.043
200	-5.73	170.6	14.39	83.4	-21.49	71.2	-17.43	-129.8	1.064
300	-5.60	158.7	11.21	73.6	-18.27	71.4	-16.90	-134.9	1.061
400	-5.65	148.4	8.97	65.5	-15.95	70.4	-15.46	-140.3	1.067
500	-5.53	137.7	7.21	58.2	-14.17	68.9	-15.41	-144.0	1.065
600	-5.33	128.4	5.85	51.4	-12.75	67.2	-14.00	-148.0	1.057
700	-5.38	117.8	4.69	46.2	-11.49	65.3	-12.82	-149.6	1.064
800	-5.59	109.5	3.83	39.8	-10.50	62.9	-11.50	-156.7	1.078
900	-5.49	101.0	2.99	34.6	-9.56	60.8	-10.80	-162.2	1.076
1000	-5.69	90.5	2.27	29.5	-8.76	58.5	-10.01	-169.2	1.091
VCE = 14 V, IC = 90 mA									
100	-6.12	-164.8	21.44	92.0	-28.07	64.6	-14.71	-99.9	0.972
200	-5.94	-179.1	15.65	82.1	-23.14	69.6	-15.64	-112.7	1.060
300	-5.83	173.2	12.20	74.6	-20.09	70.3	-14.63	-116.3	1.082
400	-5.88	167.3	9.81	67.8	-17.96	69.6	-13.38	-115.2	1.091
500	-5.91	161.9	8.05	62.0	-16.34	69.2	-12.22	-114.4	1.086
600	-6.03	156.8	6.55	56.1	-14.99	68.5	-11.15	-113.1	1.082
700	-6.15	151.4	5.33	51.1	-13.89	67.1	-10.21	-113.6	1.078
800	-6.26	146.4	4.23	46.3	-12.96	67.0	-9.44	-115.0	1.084
900	-6.33	140.6	3.33	41.9	-12.18	66.2	-8.60	-115.9	1.076
1000	-6.24	134.0	2.45	37.9	-11.42	65.7	-8.00	-118.6	1.073

Figure 9. Common Emitter S-Parameters

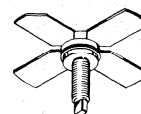
Advance Information
The RF Line
UHF Power Transistor

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment.

- 470 MHz
- 2 W — P_{out}
- 12.5 V — V_{CC}
- 10 dB Gain

PT8809A

2 W — 470 MHz
UHF POWER
TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	14.5 0.083	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 40\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 40\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	15	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	7	pF
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This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 470 \text{ MHz}$)	GPE	10	—	—	dB
Collector Efficiency ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 470 \text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 470 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 470 \text{ MHz}$)	$Z_{in} = 2 + j3.2 \text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 470 \text{ MHz}$)	$Z_{load} = 18 + j22 \text{ Ohms}$				

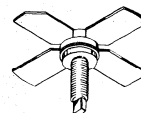
Advance Information
The RF Line
UHF Power Transistor

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment.

- 470 MHz
- 5 W — P_{out}
- 12.5 V — V_{CC}
- 8.5 dB Gain

PT8810

5 W — 470 MHz
UHF POWER
TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1.7	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	35 0.2	Watts $\text{W}/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	5	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200 \text{ mA}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	—	17	pF
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(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 470 \text{ MHz}$)	G_{PE}	8.5	—	—	dB
Collector Efficiency ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 470 \text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 470 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 470 \text{ MHz}$)	$Z_{in} = 1.6 + j3.5 \text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 470 \text{ MHz}$)	$Z_{load} = 9.5 + j5.7 \text{ Ohms}$				

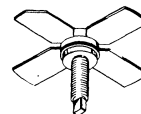
Advance Information
The RF Line
UHF Power Transistor

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment.

- 470 MHz
- 10 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

PT8811A

10 W — 470 MHz
UHF POWER
TRANSISTOR



280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	3.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 0.29	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	25	30	pF
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This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain (V _{CE} = 12.5 V, P _{out} = 10 W, f = 470 MHz)	G _{PE}	6	—	—	dB
Collector Efficiency (V _{CE} = 12.5 V, P _{out} = 10 W, f = 470 MHz)	η _c	55	—	—	%
Load Mismatch (V _{CE} = 12.5 V, P _{out} = 10 W, f = 470 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance Common Emitter (Typ) (V _{CE} = 12.5 V, P _{out} = 10 W, f = 470 MHz)	Z _{in} = 1.2 + j3 Ohms				
Load Impedance, Common Emitter (Typ) (V _{CE} = 12.5 V, P _{out} = 10 W, f = 470 MHz)	Z _{load} = 5.5 + j1.6 Ohms				

The RF Line

VHF Power Transistors

... designed for 12.5 Volt low band VHF large-signal power amplifier applications in commercial and industrial FM equipment.

- Specified 12.5 V, 50 MHz Characteristics:
 Output Power — 20 W
 Minimum Gain — 11.2 dB
 Efficiency — 60%
- Load Mismatch Capability at High Line and RF Overdrive
- Diffused Ballast Resistors

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 0.286	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 40\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

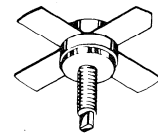
DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	10	—	200	—
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FUNCTIONAL TESTS

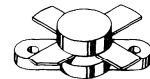
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 20\text{ W}$, $f = 50\text{ MHz}$)	G_{PE}	11.2	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 20\text{ W}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 15.5\text{ V}$, $P_{in} = 1.5\text{ W}$, $f = 50\text{ MHz}$, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

PT8852
PT8852A

11 dB
50 MHz
20 WATTS
VHF POWER
TRANSISTORS



.380 SOE
CASE 145D-01, STYLE 1
PT8852A



.380 SOE F
CASE 211-07, STYLE 1
PT8852

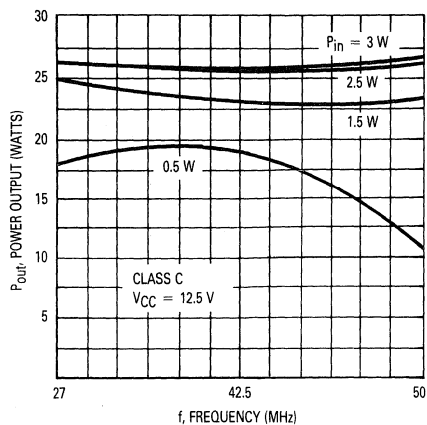


Figure 1. Output Power versus Frequency

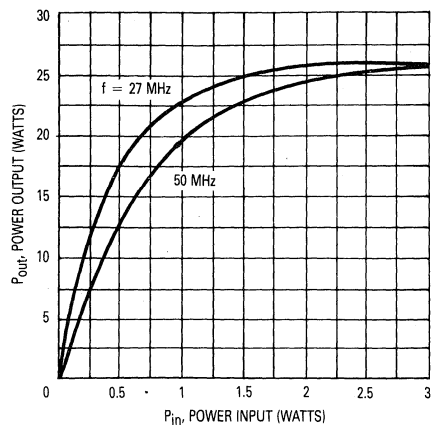


Figure 2. Output Power versus Input Power

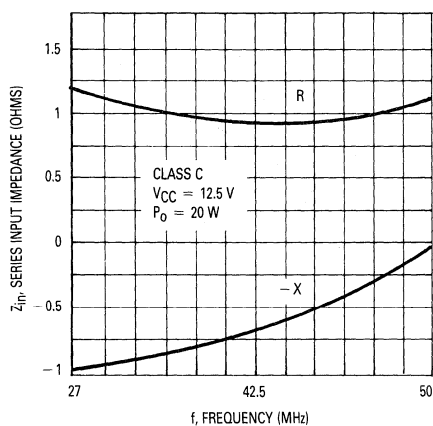


Figure 3. Series Input Impedance versus Frequency

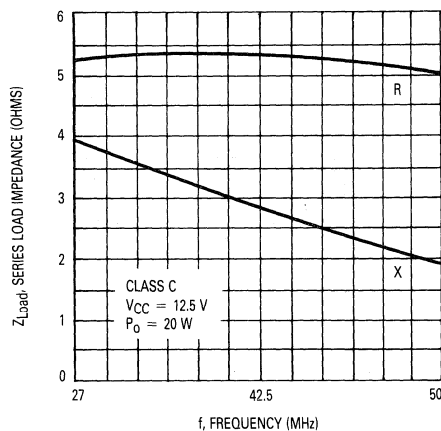


Figure 4. Series Load Impedance versus Frequency

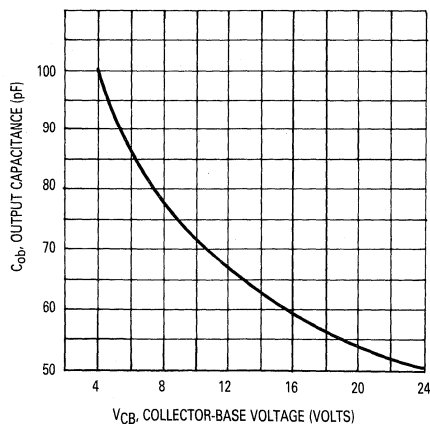
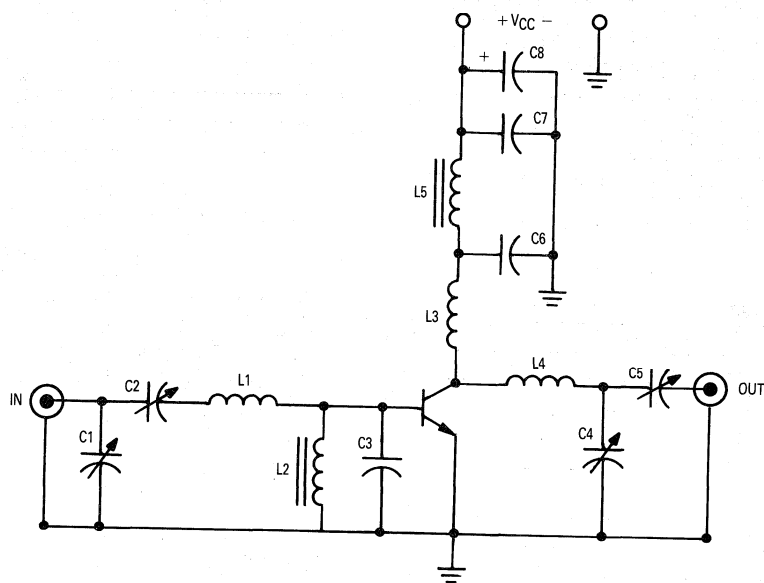


Figure 5. Output Capacitance versus Voltage



- C1, C2 — 467 ARCO
 C3, C6 — 1000 pF UNELCO
 C4, C5 — 466 ARCO
 C7 — 0.1 MFD
 C8 — 5 MFD
 L1 — 2 T. #18 AWG, 0.35 in. I.D.
 L2 — 2-1/2 T. #22 AWG on Ferroxcube VK211-073B axial core
 L3 — 3 T. #18 AWG, 0.35 in. I.D.
 L4 — 2 T. #14 AWG, 0.35 in. I.D.
 L5 — 2-1/2 T. #18 AWG on stackpole 9500-D0 A7 23-1838 core

Figure 6. Test Circuit

The RF Line

VHF Power Transistors

2

... designed for 12.5 Volt low band VHF large-signal power amplifier applications in commercial and industrial FM equipment.

- Specified 12.5 V, 50 MHz Characteristics:
 - Output Power — 35 W
 - Minimum Gain — 10 dB
 - Efficiency — 60%
- Load Mismatch Capability at High Line and RF Overdrive
- Diffused Ballast Resistors

PT8853
PT8853A

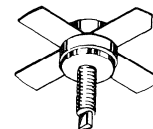
10 dB
50 MHz
35 WATTS
VHF POWER
TRANSISTORS

MAXIMUM RATINGS

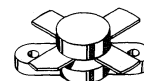
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	6	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	75 0.44	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.3	$^\circ\text{C/W}$



.380 SOE
CASE 145D-01, STYLE 1
PT8853A



.380 SOE F
CASE 211-07, STYLE 1
PT8853

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	200	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 35\text{ W}$, $f = 50\text{ MHz}$)	G_{PE}	10	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 35\text{ W}$, $f = 50\text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 15.5\text{ V}$, $P_{in} = 3.5\text{ W}$, $f = 50\text{ MHz}$, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

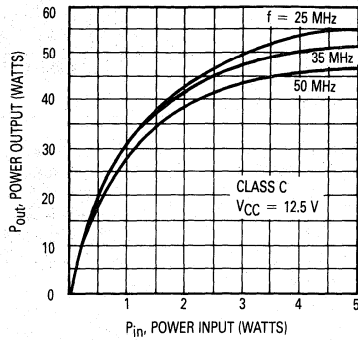


Figure 1. Output Power versus Input Power

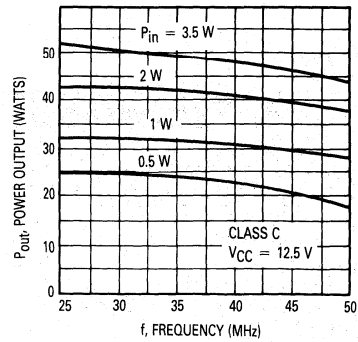


Figure 2. Output Power versus Frequency

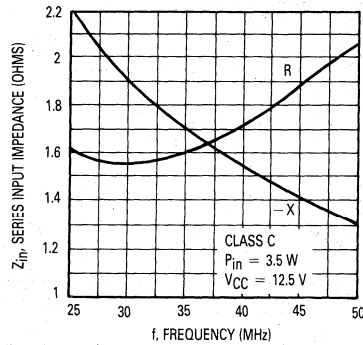


Figure 3. Series Input Impedance versus Frequency

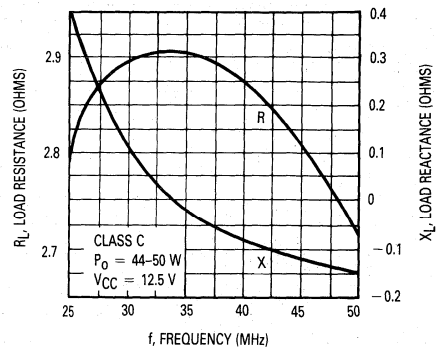


Figure 4. Series Load Impedance versus Frequency

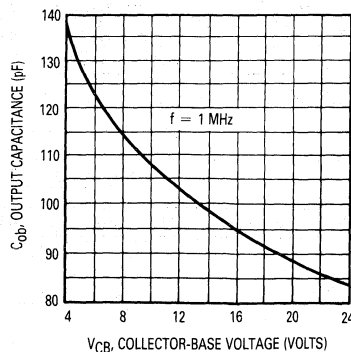


Figure 5. Output Capacitance versus Voltage

The RF Line

VHF Power Transistors

... designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

- Specified 12.5 V, 88 MHz Characteristics:
 Output Power — 12 Watts
 Minimum Gain — 8 dB
 Efficiency — 60%
- 100% Tested for Load Mismatch at All Phase Angles with 20:1 VSWR
- Diffused Ballast Resistors

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	25 0.833	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.2	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

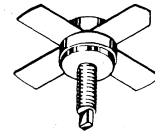
DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	200	—
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FUNCTIONAL TESTS

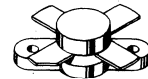
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 12\text{ W}$, $f = 88\text{ MHz}$)	G_{PE}	8.2	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 12\text{ W}$, $f = 88\text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 15.5\text{ V}$, $P_{in} = 1.8\text{ W}$, $f = 88\text{ MHz}$, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

PT8862
PT8862A

8 dB
88 MHz
12 WATTS
VHF POWER
TRANSISTORS



.380 SOE
CASE 145D-01, STYLE 1
PT8862A



.380 SOE F
CASE 211-07, STYLE 1
PT8862

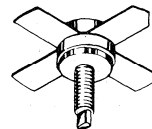
The RF Line
NPN Silicon
VHF Power Transistors

... designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

- Specified 12.5 Volt, 88 MHz Characteristics —
 Output Power = 35 Watts
 Minimum Gain = 10 dB
 Efficiency = 60%
- 100% Tested for Load Mismatch at all Phase Angles with 20:1 VSWR
- Diffused Ballast Resistors

PT8864
PT8864A

12.5 VOLT
88 MHz
VHF POWER TRANSISTORS
NPN SILICON



.380 SOE
CASE 145D-01, STYLE 1
PT8864A



.380 SOE F
CASE 211-07, STYLE 1
PT8864

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	6	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$	P_D	75	Watts
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.3	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	V
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	V
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	V
Collector Cutoff Current ($V_{CE} = 15\text{ V}$, $I_B = 0$)	I_{CES}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($V_{CE} = 10\text{ V}$, $I_C = 100\text{ mA}$)	h_{FE}	10	—	200	—
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FUNCTIONAL TESTS

Power Gain ($V_{CE} = 12.5\text{ V}$, $f = 88\text{ MHz}$, $P_{in} = 4.5\text{ W}$)	G_p	8.9	—	—	dB
Efficiency ($V_{CE} = 12.5\text{ V}$, $f = 88\text{ MHz}$, $P_{in} = 4.5\text{ W}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 15.5\text{ V}$, $P_{in} = 4.5\text{ W}$, $f = 88\text{ MHz}$, VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

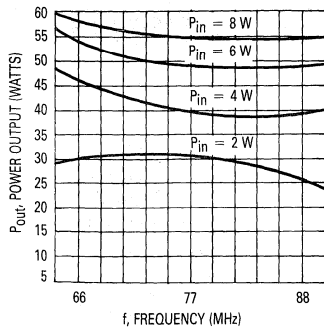
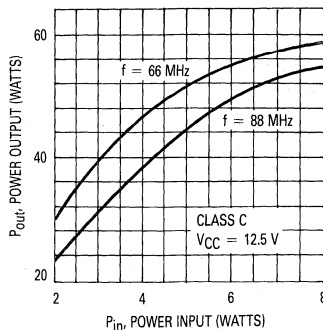
Figure 1. Broadband P_{out} versus Frequency

Figure 2. Broadband Power Transfer

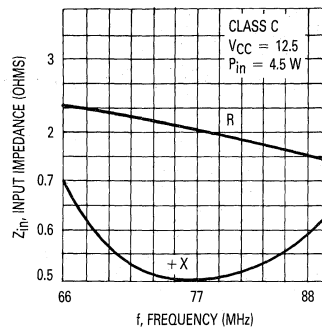


Figure 3. Series Input Impedance

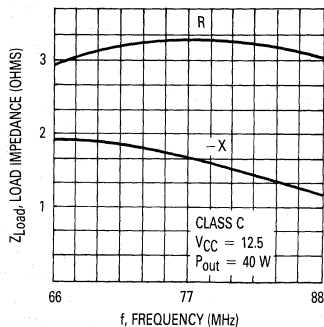


Figure 4. Series Load Impedance

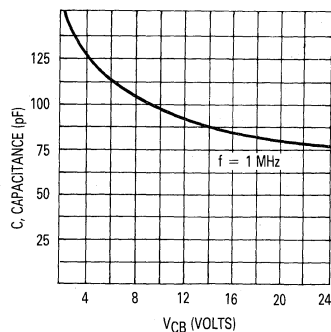
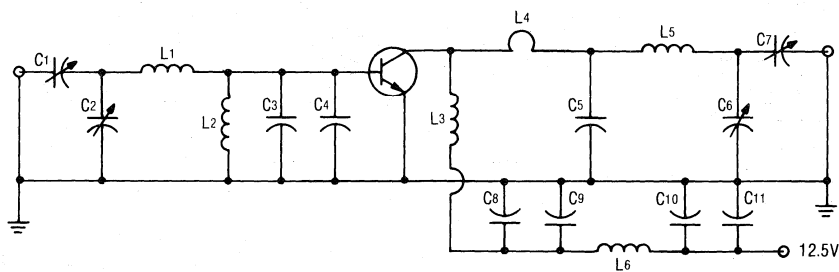


Figure 5. Output Capacitance



C1, C2, C6, C7 — 423 ARCO
 C3 — 250 pF UNELCO
 C4 — 300 pF UNELCO
 C5 — 400 pF UNELCO
 C8 — 0.001 μ F
 C9 — 500 pF UNELCO
 C10 — 0.1 μ F

C11 — 5 MFD
 L1 — 4 Turns #16 AWG, 1/4" ID, 11/16" Long
 L2 — 1-1/2 Turns #22 AWG Looped thru VK211-073B Ferroxcube Core
 L3 — 4 Turns #16 AWG, 3/16" ID, 5/16" Long
 L4 — Loop #16 AWG, 1/2" Long
 L5 — 4 Turns #16 AWG, 1/4" ID, 9/16" Long
 L6 — 1-1/2 Turns #18 AWG Looped thru CN20 Core

Figure 6. Test Circuit

The RF Line VHF Power Transistors

... designed for 12.5 Volt large-signal power amplifiers in commercial and industrial equipment.

- Specified 12.5 V, 175 MHz Characteristics:
Output Power — 40 Watts
Power Gain — 5.2 dB
Efficiency — 60%
- Diffused Emitter Resistor Ballasting
- Load Mismatch at High Line and Overdrive Conditions
- Gold Metallization for Improved Reliability

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	6	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	75 0.435	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.3	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

ON CHARACTERISTICS

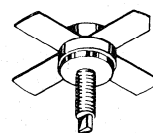
DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	200	—
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FUNCTIONAL TESTS

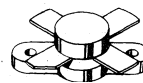
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 40\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	5.2	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 40\text{ W}$, $f = 175\text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 15.5\text{ V}$, $P_{in} = 12\text{ W}$, $f = 175\text{ MHz}$, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

PT8874
PT8874A

5.2 dB
175 MHz
40 WATTS
VHF POWER
TRANSISTORS



.380 SOE
CASE 145D-01, STYLE 1
PT8874A



.380 SOE F
CASE 211-07, STYLE 1
PT8874

TYPICAL CHARACTERISTICS

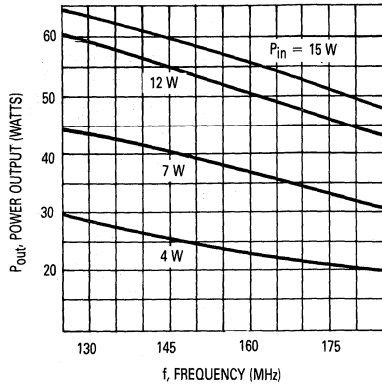


Figure 1. Output Power versus Frequency

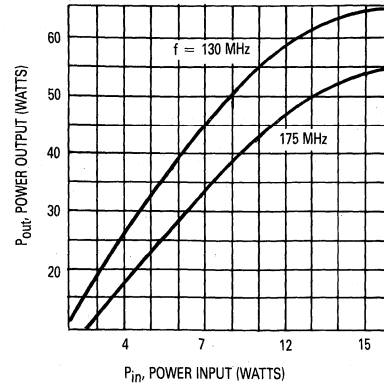


Figure 2. Output Power versus Input Power

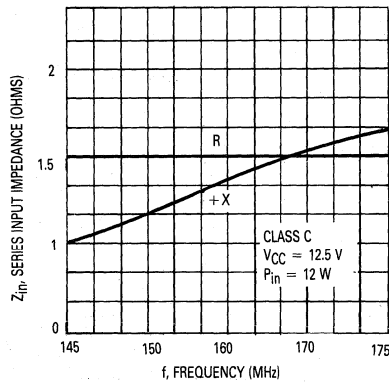


Figure 3. Series Input Impedance versus Frequency

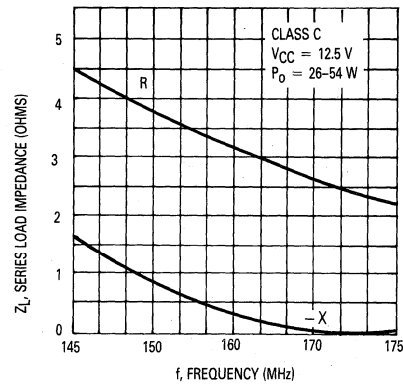


Figure 4. Series Load Impedance versus Frequency

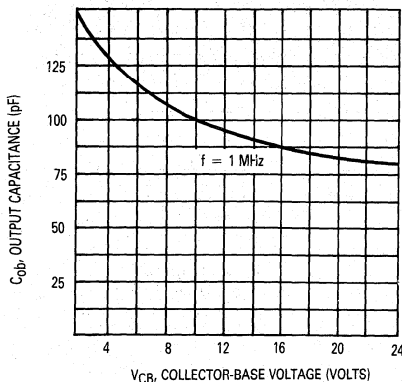


Figure 5. Output Capacitance versus Voltage

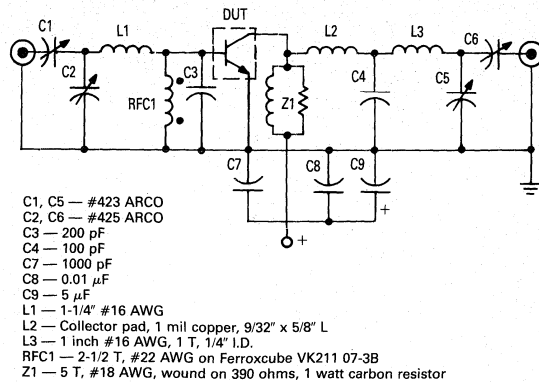


Figure 6. 175 MHz Test Circuit

Advance Information

The RF Line

UHF Power Transistor

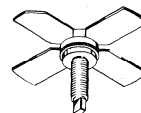
The PT9700 is a high gain transistor designed for class C operation. Microwave cellular geometries processed for UHF application provide both high gain and ruggedness.

This rugged unit is suitable for both narrow band and broadband UHF communications and instrumentation service. The product is gold metallized for long life and incorporates a ceramic stripline package.

- 400 MHz
- 1.5 W — P_{out}
- 28 V — V_{CC}
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

PT9700

1.5 W — 400 MHz
UHF POWER
TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CES}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	5 0.029	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 1 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 30 \text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	0.25	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100 \text{ mA}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	—	3.5	pF
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(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	11	—	—	dB
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 400\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 400\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28\text{ V}$, $f = 400\text{ MHz}$)	P_{sat}	2	—	—	W

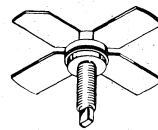
The RF Line UHF Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 200 to 500 MHz frequency range.

- Designed for Class C or Class AB Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
 - Output Power — 5 to 30 Watts
 - Power Gain — 7 to 9 dB, Min
 - Collector Efficiency — 55 to 60%, Min
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

PT9700B Series

7 TO 9 dB
TO 400 MHz
5 TO 30 WATTS
UHF POWER
TRANSISTORS



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	9701B	9703B	9702B	9704B	Unit
Collector-Emitter Voltage	V_{CEO}	30				Vdc
Collector-Base Voltage	V_{CES}	60				Vdc
Emitter-Base Voltage	V_{EBO}	4				Vdc
Collector Current — Continuous	I_C	0.75	1.25	2	5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	10 0.057	20 0.114	40 0.228	70 0.4	Watts $\text{W}/^\circ\text{C}$
Operating Junction Temperature	T_J	200				$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150				$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	8.8	4.4	2.5	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5\text{ mA}$, $I_B = 0$)	PT9701B	$V_{(BR)CEO}$	30	—	—	Vdc
	PT9703B		30	—	—	
	PT9702B		30	—	—	
	PT9704B		30	—	—	
Collector-Emitter Breakdown Voltage ($I_C = 5\text{ mA}$, $V_{BE} = 0$)	PT9701B	$V_{(BR)CES}$	60	—	—	Vdc
	PT9703B		60	—	—	
	PT9702B		60	—	—	
	PT9704B		60	—	—	
Emitter-Base Breakdown Voltage ($I_E = 0.5\text{ mA}$, $I_C = 0$)	PT9701B	$V_{(BR)EBO}$	4	—	—	Vdc
	PT9703B		4	—	—	
	PT9702B		4	—	—	
	PT9704B		4	—	—	
Collector Cutoff Current ($V_{CB} = 30\text{ V}$, $I_E = 0$)	PT9701B	I_{CBO}	—	—	0.5	mAdc
	PT9703B		—	—	1	
	PT9702B		—	—	2	
	PT9704B		—	—	3	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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ON CHARACTERISTICS

DC Current Gain ($I_C = 100 \text{ mA}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	10	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	PT9701B PT9703B PT9702B PT9704B	C_{ob}	— — — —	— — — —	6 12 24 36	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 28 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 400 \text{ MHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 10 \text{ W}$, $f = 400 \text{ MHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 20 \text{ W}$, $f = 400 \text{ MHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 30 \text{ W}$, $f = 400 \text{ MHz}$)	PT9701B PT9703B PT9702B PT9704B	G_{PE}	9 8.2 7 7	— — — —	— — — —	dB
Collector Efficiency ($V_{CE} = 28 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 400 \text{ MHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 10 \text{ W}$, $f = 400 \text{ MHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 20 \text{ W}$, $f = 400 \text{ MHz}$) ($V_{CE} = 28 \text{ V}$, $P_{out} = 30 \text{ W}$, $f = 400 \text{ MHz}$)	PT9701B PT9703B PT9702B PT9704B	η_c	55 60 60 60	— — — —	— — — —	%
Load Mismatch ($V_{CE} = 28 \text{ V}$, $f = 400 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles) $P_{out} = 5 \text{ W}$ $P_{out} = 10 \text{ W}$ $P_{out} = 20 \text{ W}$ $P_{out} = 30 \text{ W}$	PT9701B PT9703B PT9702B PT9704B	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28 \text{ V}$, $f = 400 \text{ MHz}$)	PT9701B PT9703B PT9702B PT9704B	P_{sat}	6 12 24 36	— — — —	— — — —	W

TYPICAL CHARACTERISTICS

PT9701B — 5 WATTS

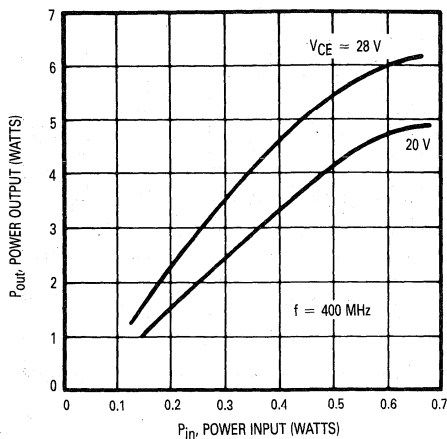


Figure 1. Output Power versus Input Power

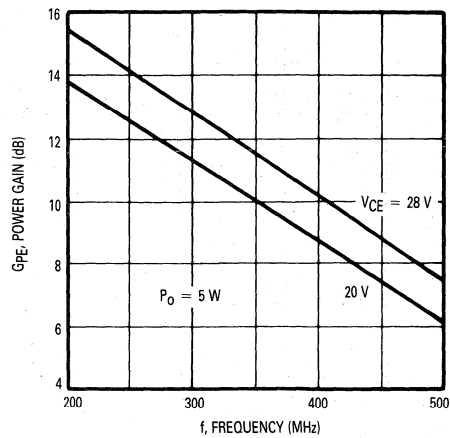


Figure 2. Power Gain versus Frequency

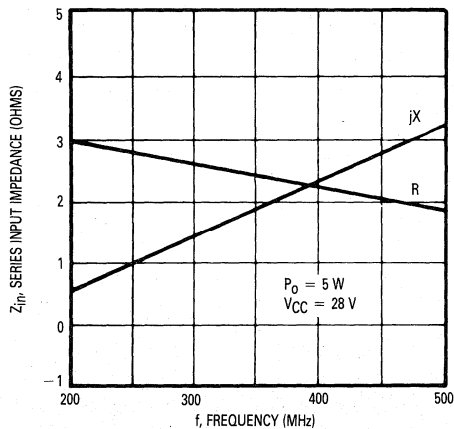


Figure 3. Series Input Impedance versus Frequency

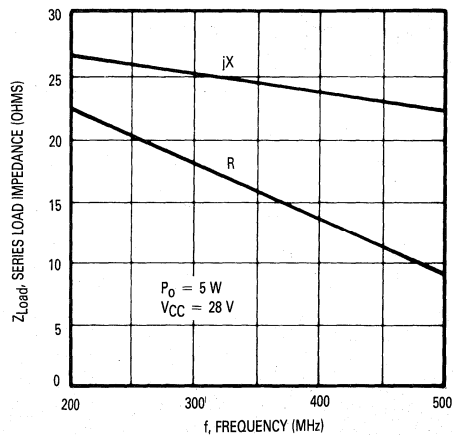


Figure 4. Series Load Impedance versus Frequency

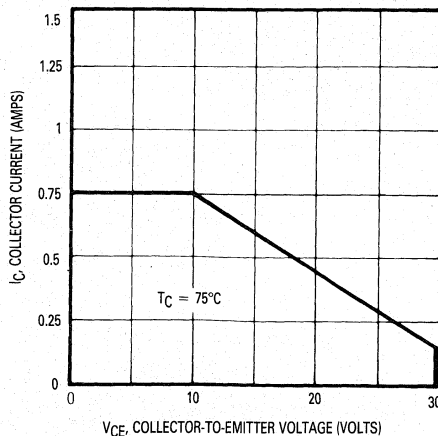


Figure 5. Safe Operating Area

TYPICAL CHARACTERISTICS

PT9703B — 10 WATTS

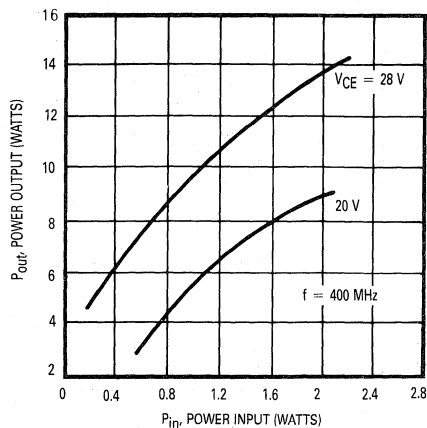


Figure 6. Output Power versus Input Power

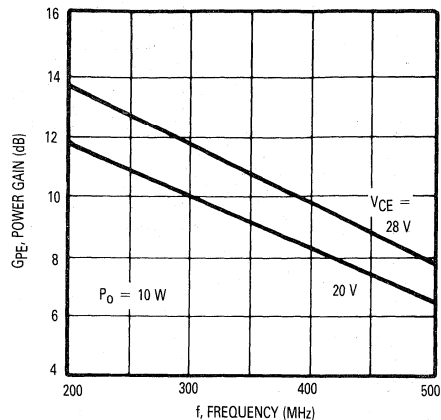


Figure 7. Power Gain versus Frequency

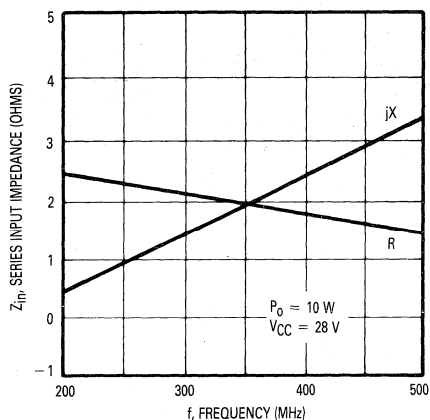


Figure 8. Series Input Impedance versus Frequency

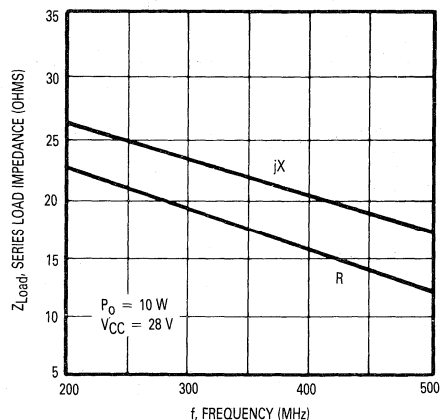


Figure 9. Series Load Impedance versus Frequency

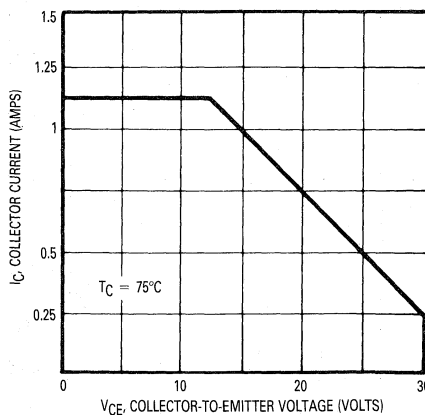


Figure 10. Safe Operating Area

TYPICAL CHARACTERISTICS

PT9702B — 20 WATTS

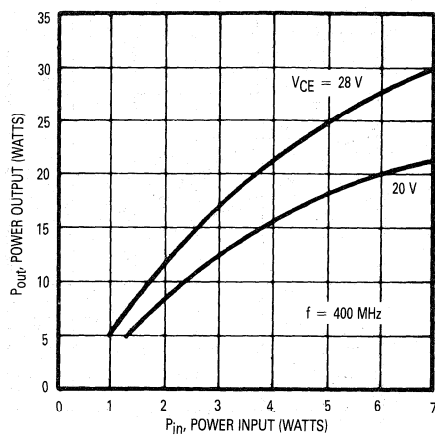


Figure 11. Output Power versus Input Power

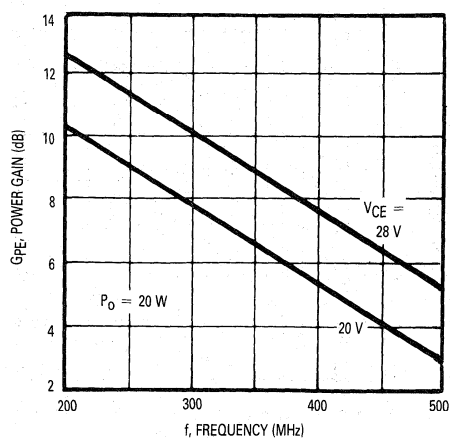


Figure 12. Power Gain versus Frequency

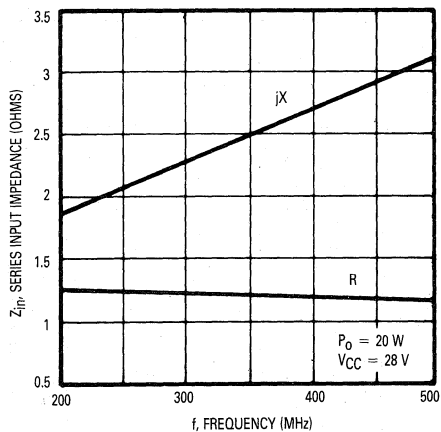


Figure 13. Series Input Impedance versus Frequency

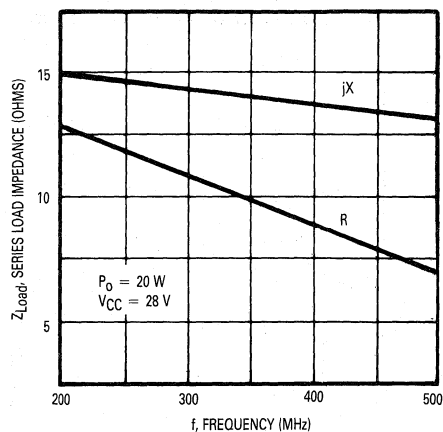


Figure 14. Series Load Impedance versus Frequency

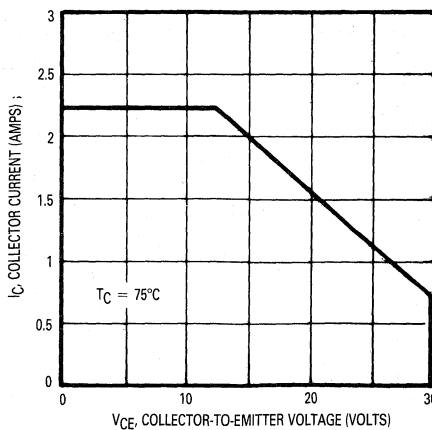


Figure 15. Safe Operating Area

TYPICAL CHARACTERISTICS

PT9704B — 30 WATTS

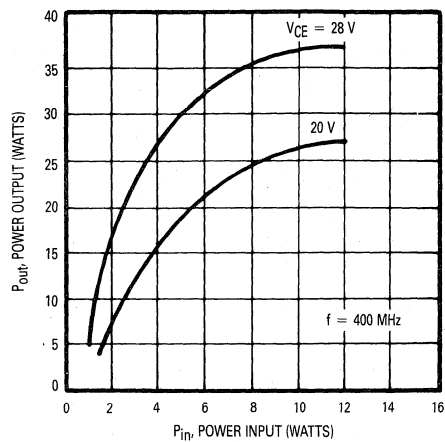


Figure 16. Output Power versus Input Power

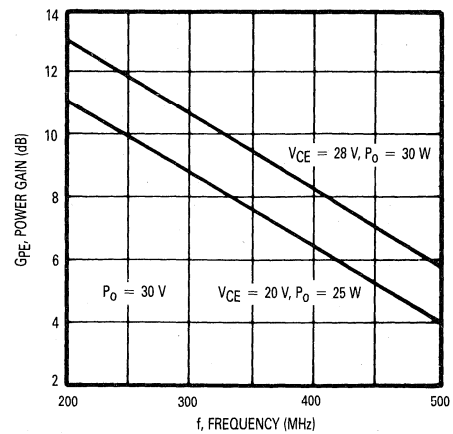


Figure 17. Power Gain versus Frequency

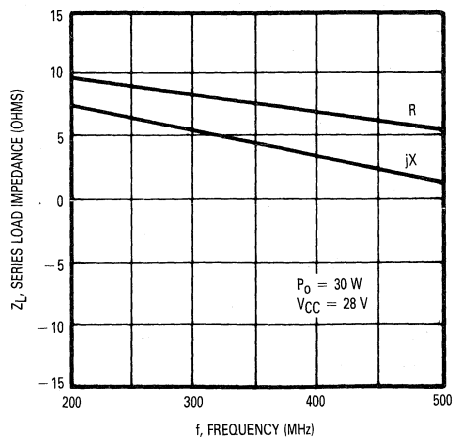


Figure 18. Load Impedance versus Frequency

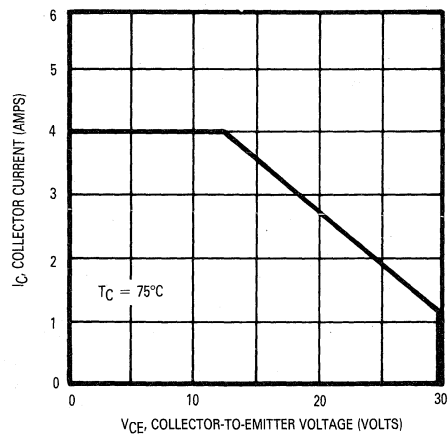


Figure 19. Safe Operating Area

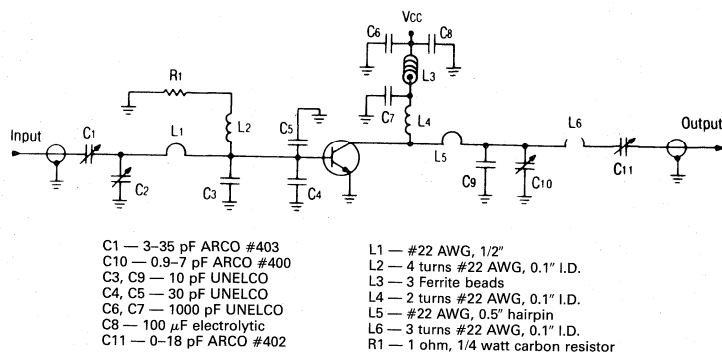


Figure 20. 400 MHz Test Circuit
(for PT9701B and PT9703B)

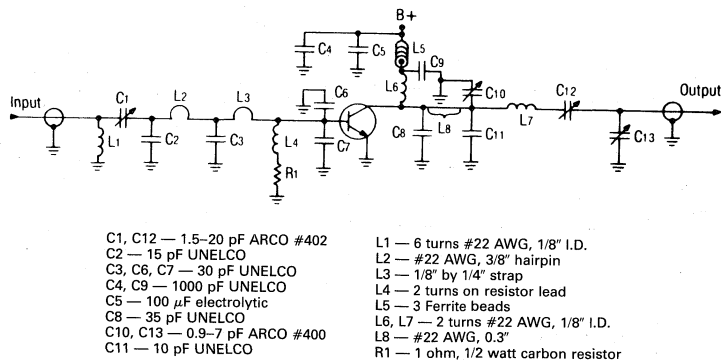


Figure 21. 400 MHz Test Circuit
(for PT9702B and PT9704B)

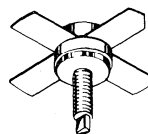
The RF Line VHF Power Transistors

... designed primarily for wideband, large-signal output amplifier stages in the 30–200 MHz frequency range.

- Guaranteed Performance at 175 MHz, 28 Vdc
Output Power — 4 to 25 Watts
Minimum Gain — 10 to 13 dB
Collector Efficiency — 60%, Min
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

PT9730 Series

**10 TO 13 dB
TO 200 MHz
4 TO 25 WATTS
VHF POWER
TRANSISTORS**



**.380 SOE
CASE 145D-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	9730	9732	9734	9731	Unit
Collector-Emitter Voltage	V_{CEO}	35				Vdc
Collector-Base Voltage	V_{CES}	60				Vdc
Emitter-Base Voltage	V_{EBO}	4				Vdc
Collector Current — Continuous	I_C	1	1.25	2.5	4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	10 0.06	20 0.114	30 0.173	45 0.257	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200				$^\circ\text{C}$
Storage Temperature Range	T_{stg}	– 65 to + 150				$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	8.8	5.8	3.9	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 25\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	0.5 1 1.5 2	mAdc
	PT9730	—	—	0.5	
	PT9732	—	—	1	
	PT9734	—	—	1.5	
	PT9731	—	—	2	

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	12 18 24 40	pF
	PT9730	—	—	12	
	PT9732	—	—	18	
	PT9734	—	—	24	
	PT9731	—	—	40	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28 \text{ V}$, $P_{out} = \text{Rated}$, $f = 175 \text{ MHz}$)	PT9730 PT9732 PT9734 PT9731	GPE	13 12 11.8 10	— — — —	dB
Collector Efficiency ($V_{CE} = 28 \text{ V}$, $P_{out} = \text{Rated}$, $f = 175 \text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 28 \text{ V}$, $P_{out} = \text{Rated}$, $f = 175 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28 \text{ V}$, $f = 175 \text{ MHz}$)	PT9730 PT9732 PT9734 PT9731	P_{sat}	6 10 18 30	— — — —	W

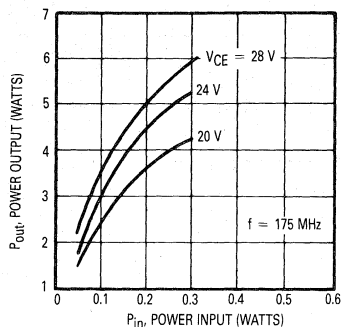
TYPICAL CHARACTERISTICS
PT9730 — 4 WATTS

Figure 1. Power Input versus Power Output

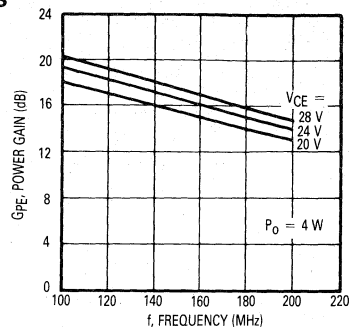


Figure 2. Power Gain versus Frequency

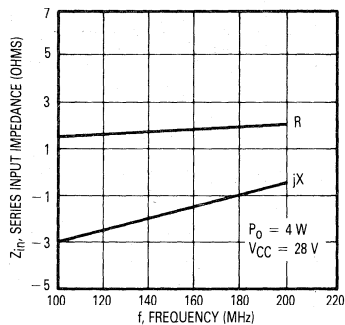


Figure 3. Series Input Impedance versus Frequency

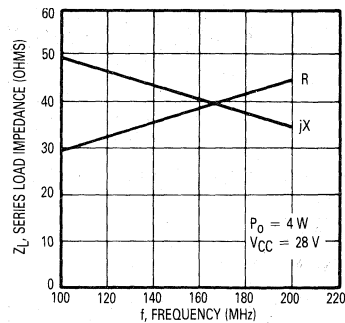


Figure 4. Series Load Impedance versus Frequency

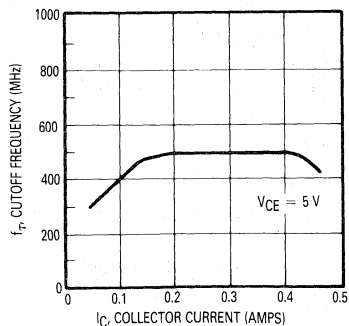


Figure 5. Cutoff Frequency versus Current

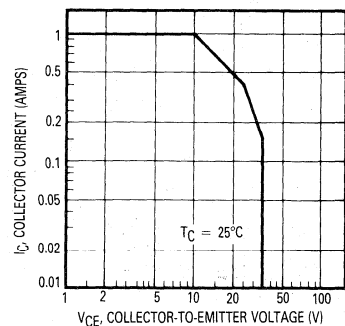


Figure 6. Safe Operating Area

TYPICAL CHARACTERISTICS
PT9732 — 8 WATTS

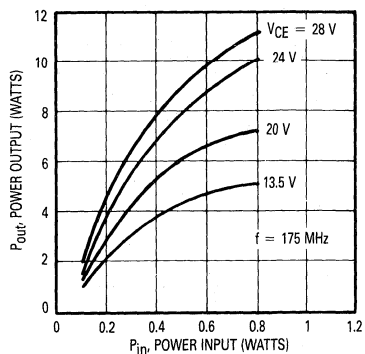


Figure 7. Power Output versus Power Input

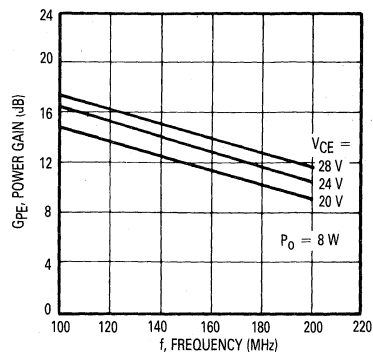


Figure 8. Power Gain versus Frequency

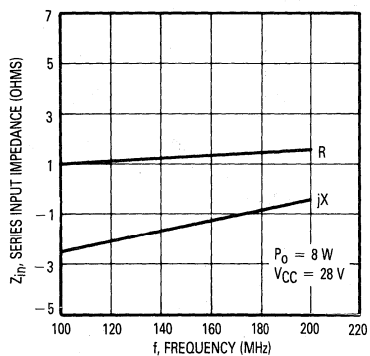


Figure 9. Series Input Impedance versus Frequency

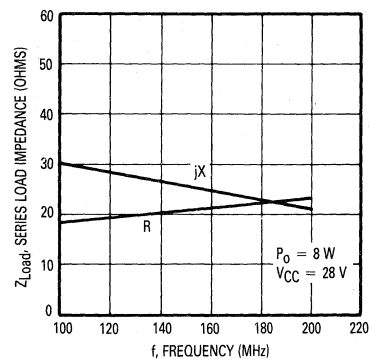


Figure 10. Series Load Impedance versus Frequency

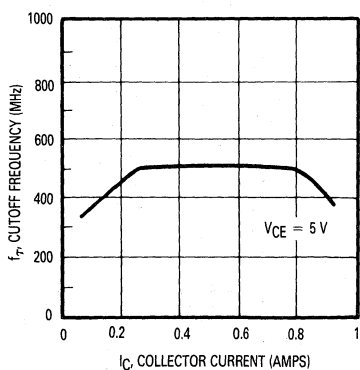


Figure 11. Cutoff Frequency versus Current

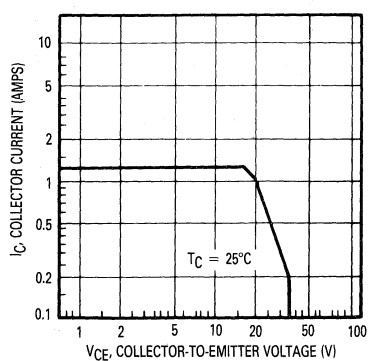


Figure 12. Safe Operating Area

TYPICAL CHARACTERISTICS
PT9734 — 15 WATTS

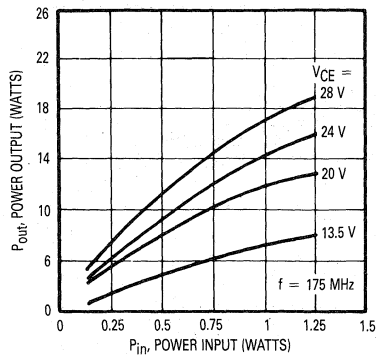


Figure 13. Power Output versus Power Input

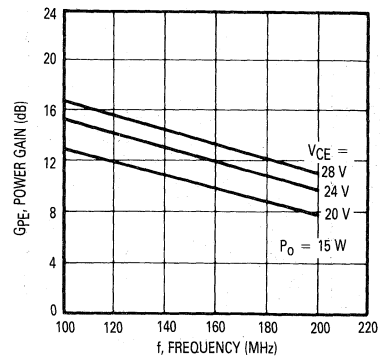


Figure 14. Power Gain versus Frequency

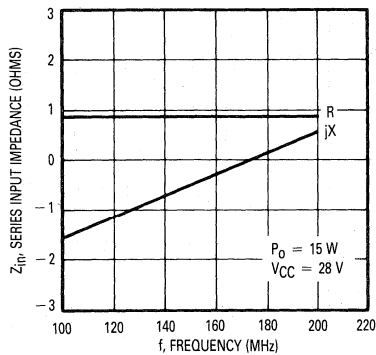


Figure 15. Series Input Impedance versus Frequency

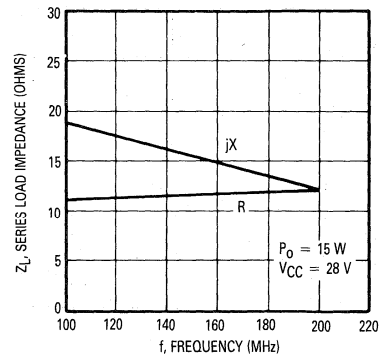


Figure 16. Series Load Impedance versus Frequency

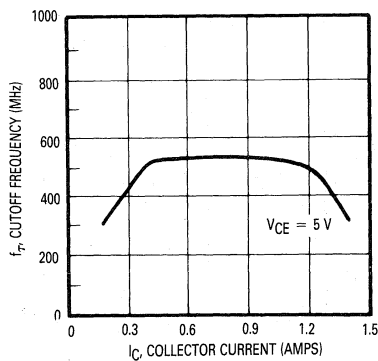


Figure 17. Cutoff Frequency versus Current

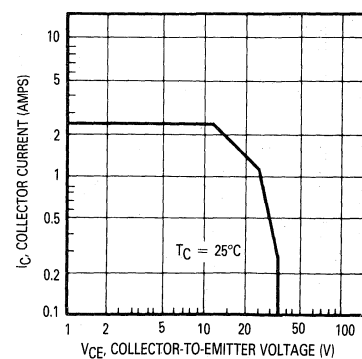


Figure 18. Safe Operating Area

TYPICAL CHARACTERISTICS PT9731 — 25 WATTS

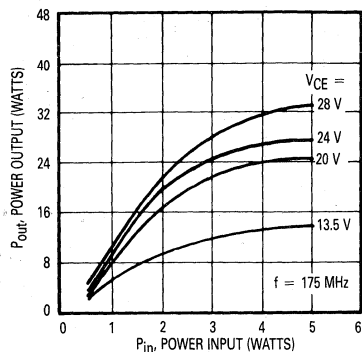


Figure 19. Power Output versus Power Input

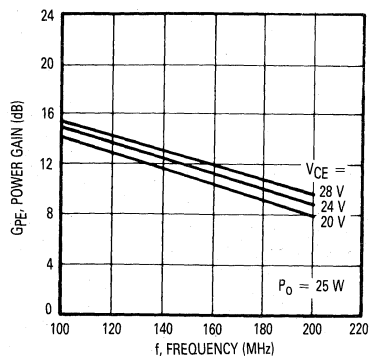


Figure 20. Power Gain versus Frequency

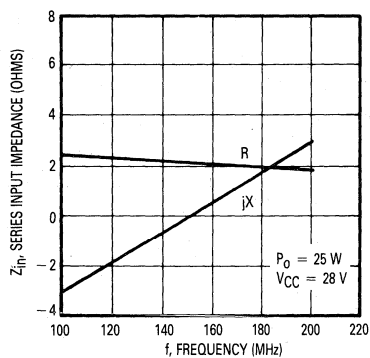


Figure 21. Series Input Impedance versus Frequency

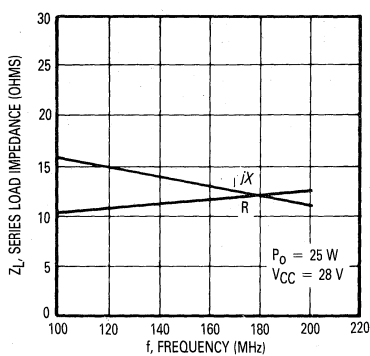


Figure 22. Series Load Impedance versus Frequency

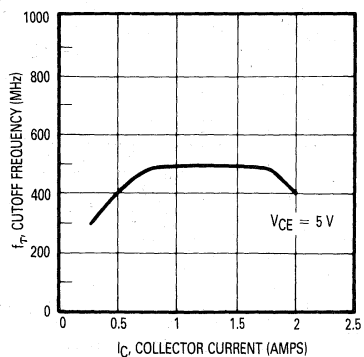


Figure 23. Cutoff Frequency versus Current

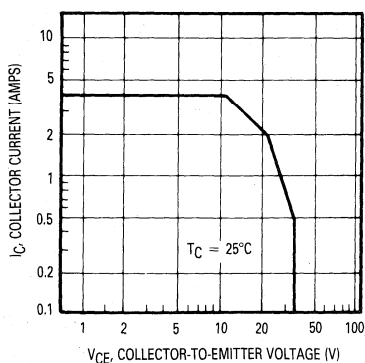


Figure 24. Safe Operating Area

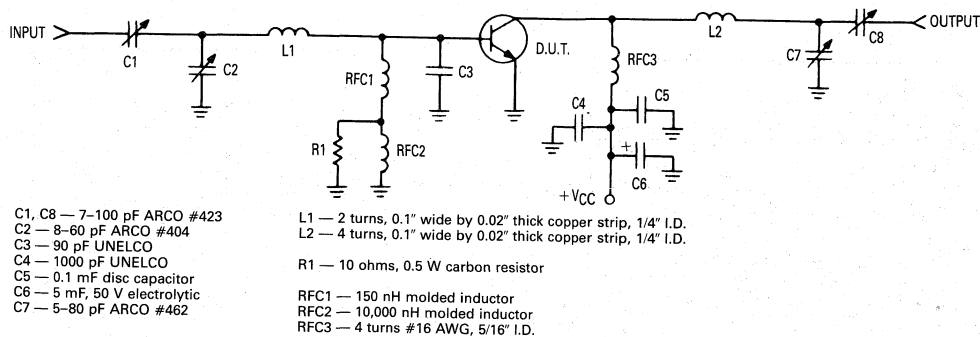


Figure 25. 175 MHz Test Circuit (PT9731)

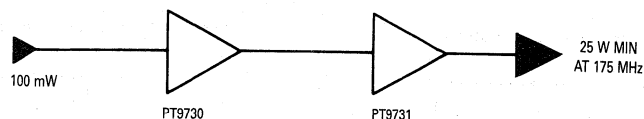
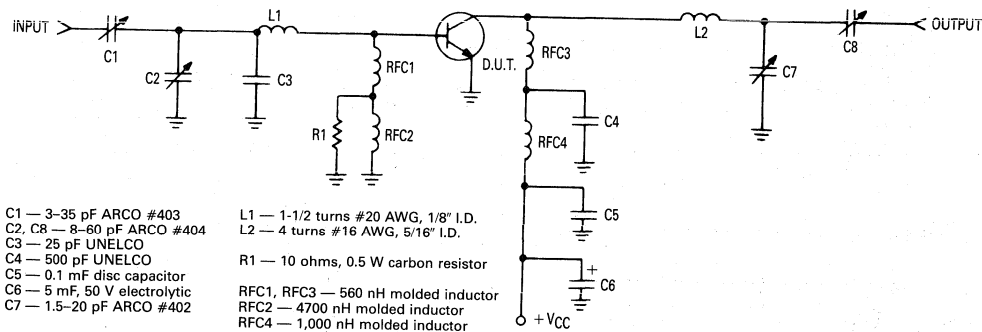
Figure 26. Typical Application
25 Watt VHF 24 V Power Amplifier

Figure 27. 175 MHz Test Circuit (PT9730 and PT9732)

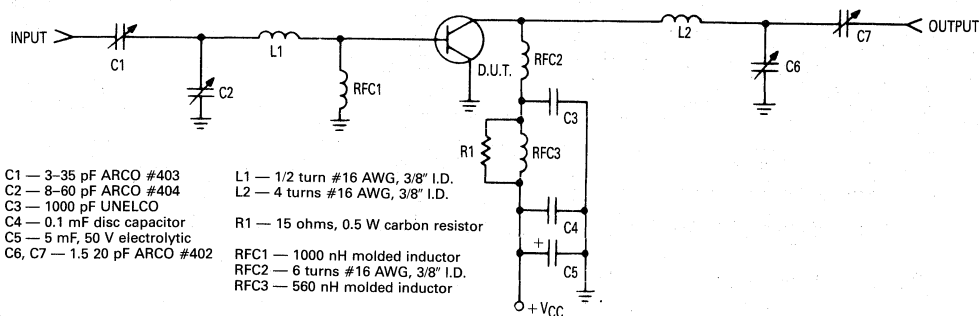


Figure 28. 175 MHz Test Circuit (PT9734)

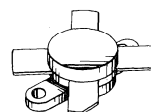
The RF Line SSB Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 30 MHz frequency range.

- Designed for Class AB Linear Power Amplifiers
- Specified 28 Volt, 28 MHz Characteristics:
Output Power — 100 Watts PEP
Power Gain — 14 dB Min, Class AB
- 100% Tested for Load Mismatch at All Phase Angles with $\infty:1$ VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

PT9780

**14 dB
2-30 MHz
100 WATTS PEP
28 VOLTS
SSB POWER
TRANSISTOR**



**.500 SOE F
CASE 211-11, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	20	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ mA, $I_E = 0$)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28$ V, $V_{BE} = 0$)	I_{CES}	—	—	25	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	10	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	290	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28 \text{ V}$, $P_{out} = 100 \text{ W PEP}$, $f = 28 \text{ MHz}$, $I_{CQ} = 100 \text{ mA}$)	G _{PE}	14	—	—	dB
Load Mismatch ($V_{CE} = 28 \text{ V}$, $P_{out} = 100 \text{ W PEP}$, $f = 28 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion ($V_{CE} = 28 \text{ Vdc}$, $P_{out} = 100 \text{ W PEP}$, $I_{CQ} = 100 \text{ mA}$, $f = 28 \text{ MHz}$)	IMD	—	—	-32	dB

TYPICAL CHARACTERISTICS

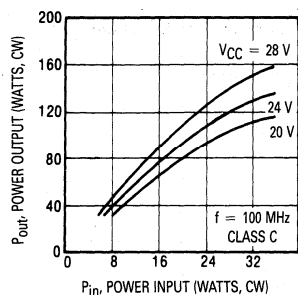
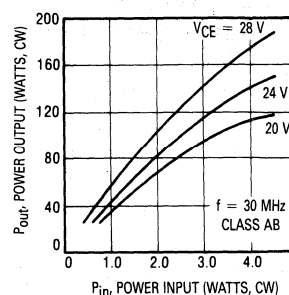
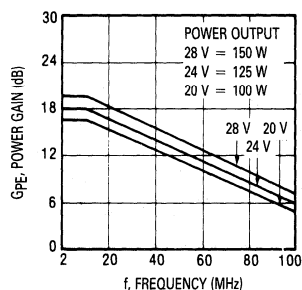
Figure 1. Power Output versus Power Input
 $f = 100 \text{ MHz}$ Figure 2. Power Output versus Power Input
 $f = 30 \text{ MHz}$ 

Figure 3. Power Gain versus Frequency

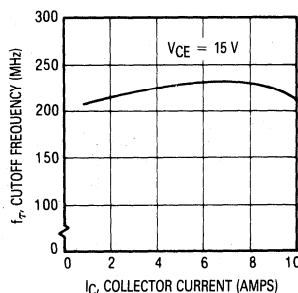


Figure 4. Cutoff Frequency versus Current

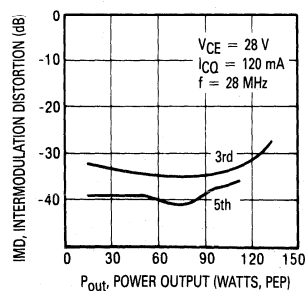


Figure 5. IMD versus Power Output

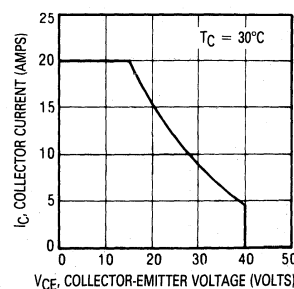


Figure 6. DC Safe Operating Area

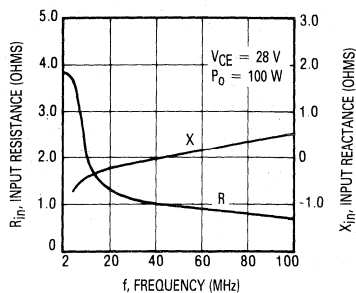


Figure 7. Series Input Impedance versus Frequency

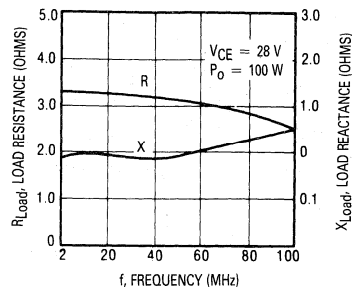


Figure 8. Series Load Impedance versus Frequency

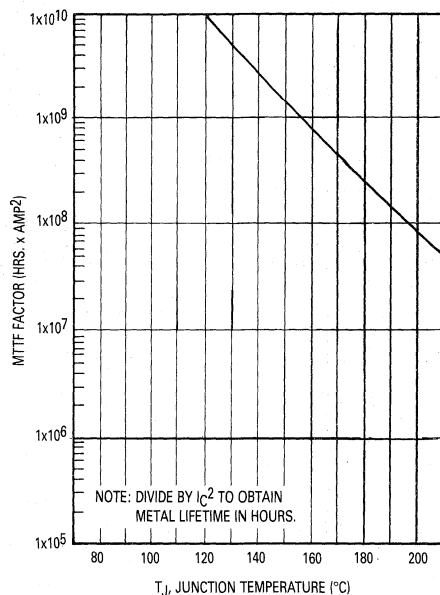


Figure 9. MTTF Factor versus Junction Temperature

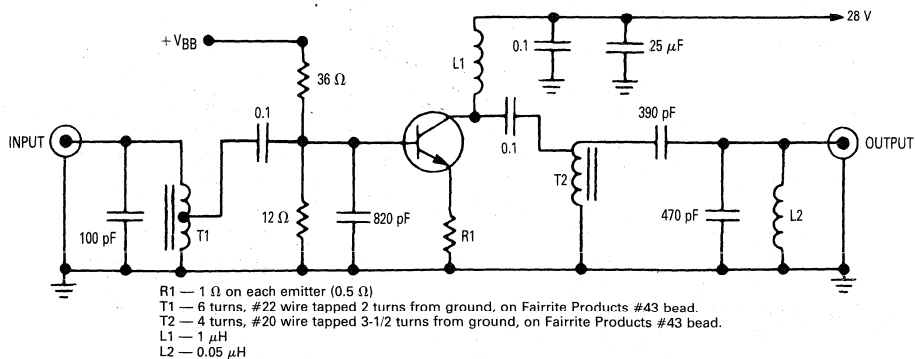


Figure 10. 28 MHz Test Circuit

The RF Line SSB Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 30 MHz frequency range.

- Designed for Class A, AB and C Power Amplifiers
- Specified 28 Volt, 28 MHz Characteristics:
Output Power — 50 Watts PEP
Power Gain — 14 dB Min, Class AB
- 100% Tested for Load Mismatch at All Phase Angles with $\infty:1$ VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

PT9783
PT9783A

14 dB
2-30 MHz
50 WATTS PEP
28 VOLTS
SSB POWER
TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	175 1	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2.5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 28\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	25	mAdc

ON CHARACTERISTICS

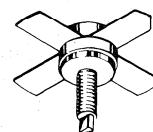
DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	100	—
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DYNAMIC CHARACTERISTICS

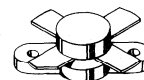
Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	150	—	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 50\text{ W PEP}$, $f = 28\text{ MHz}$, $I_{CQ} = 60\text{ mA}$)	G_{PE}	14	—	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 50\text{ W PEP}$, $f = 28\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion ($V_{CE} = 28\text{ Vdc}$, $P_{out} = 50\text{ W PEP}$, $I_{CQ} = 60\text{ mA}$, $f = 28\text{ MHz}$)	IMD	—	—	-32	dB



.380 SOE
CASE 145D-01, STYLE 1
PT9783A



.380 SOE F
CASE 211-07, STYLE 1
PT9783

TYPICAL CHARACTERISTICS

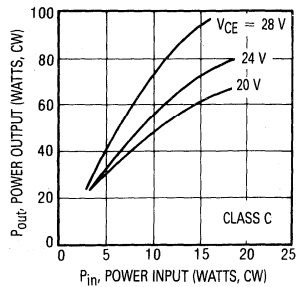


Figure 1. Power Output versus Power Input
 $f = 100 \text{ MHz}$

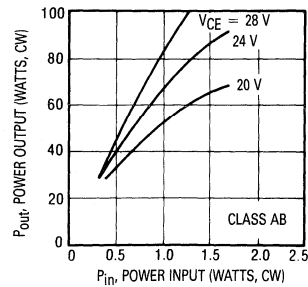


Figure 2. Power Output versus Power Input
 $f = 30 \text{ MHz}$

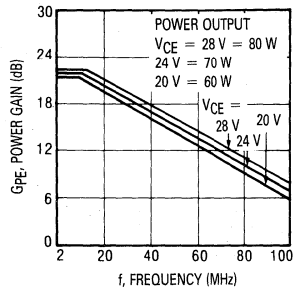


Figure 3. Power Gain versus Frequency

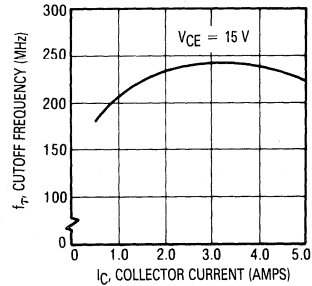


Figure 4. Cutoff Frequency versus Current

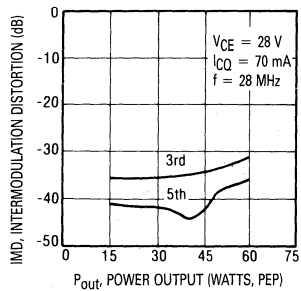


Figure 5. IMD versus Power Output

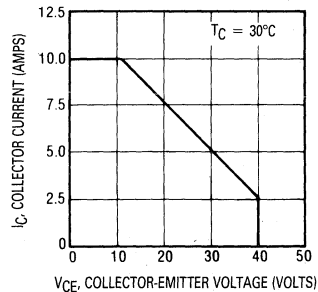


Figure 6. DC Safe Operating Area

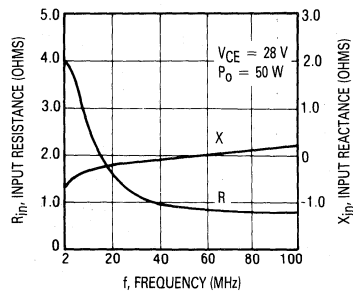


Figure 7. Series Input Impedance versus Frequency

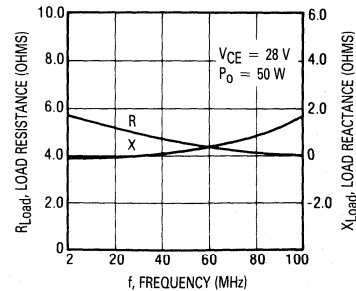


Figure 8. Series Load Impedance versus Frequency

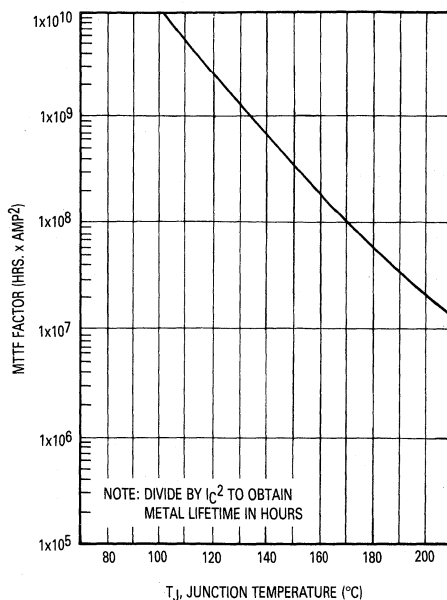
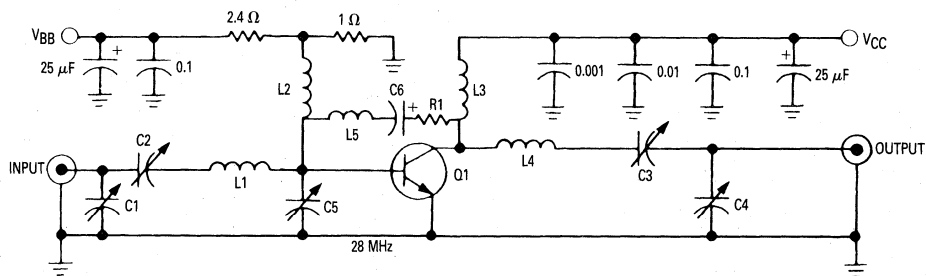


Figure 9. MTTF Factor versus Junction Temperature



C1 — ARCO #467, 110–580 pF
 C2, C3, C4 — ARCO #466, 80–480 pF
 C5 — ARCO #469, 170–780 pF
 C6 — 5 μ F, 50 V ELE
 R1 — 50 Ω , 2 W
 L1, L4 — 5 turns #14 tinned copper, 0.5" mean diameter, 1 equals 1.0"
 L2 — 10 turns #18 AWG, 0.5" mean diameter
 L3 — 4 turns #20 AWG through two Stackpole #23-1838 cores
 L5 — 6.8 μ H molded
 VCC — 28 V
 VBB — 1.6 volts (I_C [Quies] = 100 mA)

Figure 10. 28 MHz Test Circuit

The RF Line

SSB Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 30 MHz frequency range.

- Designed for Class A, AB or C Power Amplifiers
- Specified 13.5 Volt, 28 MHz Characteristics:
 - Output Power — 75 Watts PEP
 - Power Gain — 15 dB Min, Class AB
- 100% Tested for Load Mismatch at All Phase Angles with $\infty:1$ VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	175 0.572	Watts $\text{W}/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage ($I_C = 100\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 6\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 13.5\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

ON CHARACTERISTICS

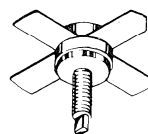
DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	25	—	150	—
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FUNCTIONAL TESTS

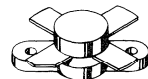
Common-Emitter Amplifier Power Gain ($V_{CE} = 13.5\text{ V}$, $P_{out} = 75\text{ W PEP}$, $f = 28\text{ MHz}$)	G_{PE}	15	—	—	dB
Load Mismatch ($V_{CE} = 13.5\text{ V}$, $P_{out} = 75\text{ W PEP}$, $f = 28\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion ($V_{CE} = 13.5\text{ Vdc}$, $P_{out} = 75\text{ W PEP}$, $f = 28\text{ MHz}$)	IMD	—	-32	—	dB

PT9784
PT9784A

15 dB
 2-30 MHz
 75 WATTS PEP
 13.5 VOLTS
 SSB POWER
 TRANSISTORS



.380 SOE
CASE 145D-01, STYLE 1
PT9784A



.380 SOE F
CASE 211-07, STYLE 1
PT9784

TYPICAL CHARACTERISTICS

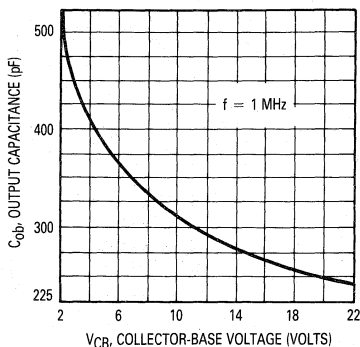


Figure 1. Output Capacitance versus Voltage

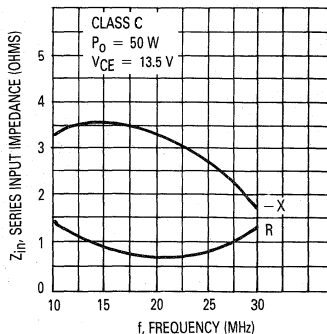


Figure 2. Series Input Impedance versus Frequency

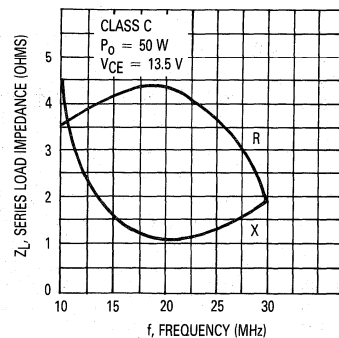
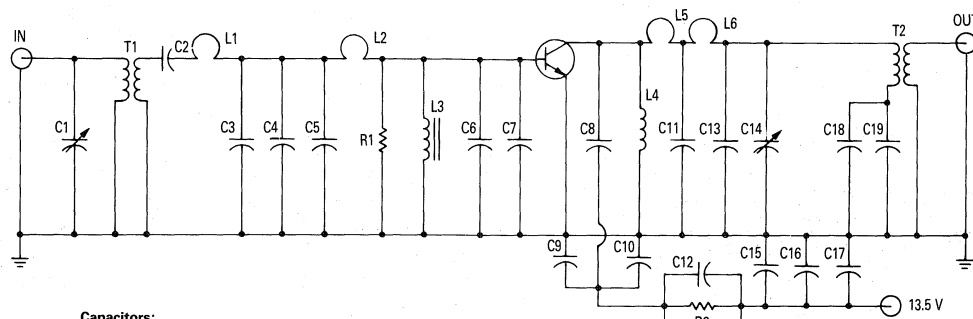


Figure 3. Series Load Impedance versus Frequency



Capacitors:
 C1 — 423 ARCO
 C2, C3, C4, C6, C7, C9, C10, C13, C18, C19 — 1000 pF UNELCO
 C5 — 500 pF UNELCO
 C8 — 400 pF UNELCO
 C11 — 250 pF UNELCO
 C12, C15 — 0.1 Disc.
 C14 — 469 ARCO
 C16 — 0.01 Disc.
 C17 — 25 MFD, 35 Volts

Resistors:
 R1 — 51 Ohms
 R2 — 16 Ohms 2 W

Coils:
 L1 — #18 AWG, 1-3/8" Long, Looped 3/8" Curve
 L2 — #18 AWG, 1-1/8" Long, Looped 1/4" Curve
 L3 — 2-1/2 T, #24 AWG, Looped thru Ferroxcube VK21107-3B
 L4 — 8 T, #18 AWG, 2 ID, 5/8" Long
 L5 — #18 AWG, 1/4" Long, straight
 L6 — #18 AWG, 1/2" Long, Looped 3/8" Curve
 L7 — 10 T, #20 AWG, Enamel, Wrapped around 16 Ohm, 2 Watt resistor

Transformers:
 T1 — Primary — 4 T, #22 AWG, Teflon insulated
 Secondary — Brass Tube, Length — 11/16"
 T2 — Primary — Brass Tube, Secondary — 3 T, #22 AWG
 Teflon insulated, Length — 1-1/4"

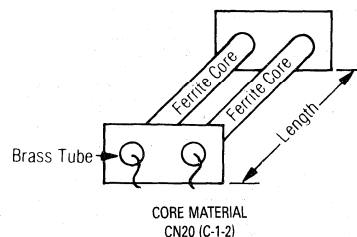


Figure 4. 28 MHz Test Circuit

PT9785

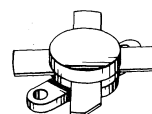
The RF Line
SSB Power Transistor

2

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 30 MHz frequency range.

- Designed for Class A, AB or C Power Amplifiers
- Specified 13.5 Volt, 28 MHz Characteristics:
Output Power — 100 Watts PEP
Power Gain — 13 dB Min, Class AB
- 100% Tested for Load Mismatch at all Phase Angles with $\infty:1$ VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

13 dB
2-30 MHz
100 WATTS PEP
13.5 VOLTS
SSB POWER
TRANSISTOR



.500 SOE F
CASE 211-11, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	25	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	350 2	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Base Breakdown Voltage ($I_C = 100\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 13.5\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	20	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 2\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	100	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 13.5\text{ V}$, $P_{out} = 100\text{ W PEP}$, $f = 28\text{ MHz}$)	G_{PE}	13	—	—	dB
Load Mismatch ($V_{CE} = 13.5\text{ V}$, $P_{out} = 100\text{ W PEP}$, $f = 28\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion ($V_{CE} = 12.5\text{ Vdc}$, $P_{out} = 100\text{ W PEP}$, $f = 28\text{ MHz}$)	IMD	—	-32	—	dB

TYPICAL CHARACTERISTICS

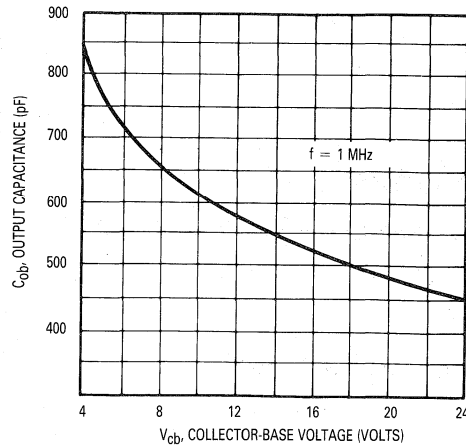
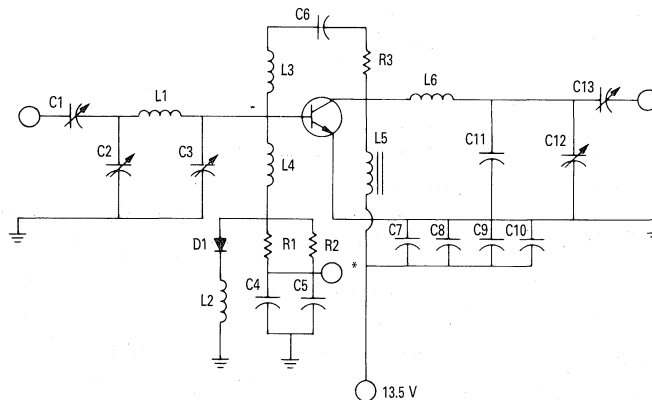


Figure 1. Output Capacitance versus Voltage



C1 — 425 ARCO
 C2 — 467 ARCO
 C3 — 469 ARCO
 C4 — 0.1 μ F
 C5, C6 — 5 μ F
 C7, C8 — 0.1 μ F
 C9 — 100 μ F
 C10 — 1000 pF UNELCO
 C11 — 100 pF UNELCO
 C12 — 466 ARCO
 C13 — 427 ARCO

*Note: Set voltage for 100 mA idle collector current.

L1 — 4 T., #16 AWG, 7/16" ID, 3/4" Long with 5/8" long lead on base side.
 L2 — 0.33 μ H Delevan
 L3 — 10 μ H Delevan
 L4 — 1 μ H Delevan
 L5 — 4 T., #20 wire wound on 2 Stackpole Carbon Co. Ferrite #9500 DO A723-1838.
 L6 — 4 T., #10 AWG, 1/2" ID, 1" long.
 D1 — Power diode
 R1, R2 — 2.7 Ohms
 R3 — 51 Ohms 2W

Figure 2. 28 MHz Test Circuit

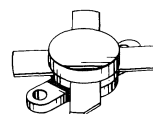
The RF Line **SSB Power Transistor**

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 30 MHz frequency range.

- Designed for Class A, AB or C Power Amplifiers
- Specified 50 Volt, 28 MHz Characteristics:
Output Power — 150 Watts PEP
Power Gain — 15 dB Min, Class AB
- 100% Tested for Load Mismatch at all Phase Angles with $\infty:1$ VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

PT9790

**15 dB
2-30 MHz
150 WATTS PEP
50 VOLTS
SSB POWER
TRANSISTOR**



**.500 SOE F
CASE 211-11, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	55	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	300 2	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CEO}$	55	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ mA, $I_E = 0$)	$V_{(BR)CBO}$	110	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	10	—	60	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	200	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 50\text{ V}$, $P_{out} = 150\text{ W PEP}$, $f = 28\text{ MHz}$, $I_{CQ} = 50\text{ mA}$)	GpE	15	—	—	dB
Load Mismatch ($V_{CE} = 50\text{ V}$, $I_Q = 50\text{ mA}$, $P_{out} = 150\text{ W PEP}$, $f = 28\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion ($V_{CE} = 50\text{ Vdc}$, $P_{out} = 150\text{ W PEP}$, $I_{CQ} = 50\text{ mA}$, $f = 28\text{ MHz}$)	IMD	—	—	-32	dB

TYPICAL CHARACTERISTICS

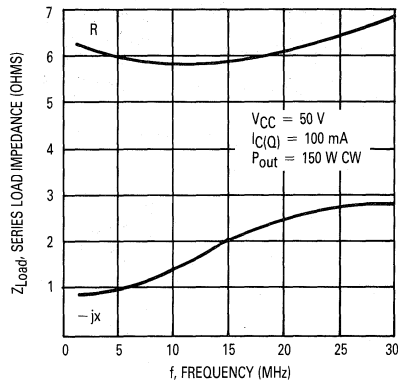


Figure 1. Series Load Impedance versus Frequency

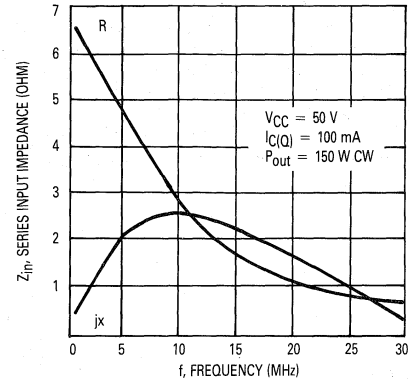


Figure 2. Series Input Impedance versus Frequency

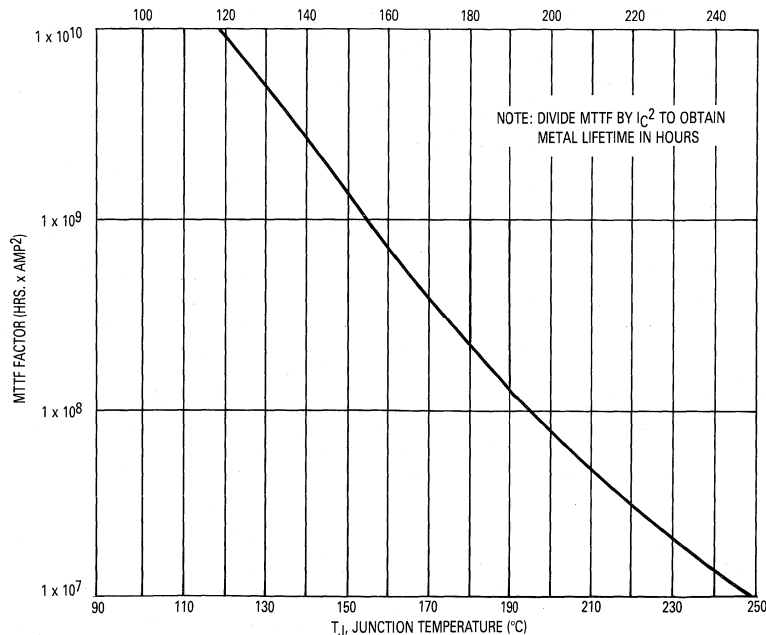
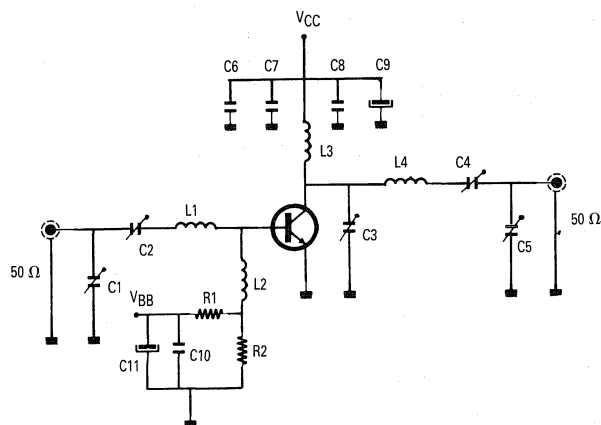


Figure 3. MTTF Factor versus Junction Temperature



C1, C5 — 170–780 pF, ARCO 469 Trimmer capacitor
 C2, C4 — 80–480 pF, ARCO 466 Trimmer capacitor
 C3 — 55–300 pF, ARCO 427 Trimmer capacitor
 C6 — 1000 pF Mica Capacitor UNELCO
 C7 — 10 μ F Ceramic Disc
 C8, C10 — 0.1 μ F Ceramic Disc
 C9, C11 — 470 μ F/63 V Electrolytic

L1 — 5 turns 15/10 mm Silvered wire, 10 mm ID, 25 mm length
 L2 — 10 turns 8/10 mm Enameled wire, 10 mm ID
 L3 — 4 turns 12/10 mm Enameled wire, 10 mm ID, 10 mm length
 L4 — 7 turns 15/10 mm Enameled wire, 10 mm ID, 20 mm length

R1 — 1 Ω , 2 W
 R2 — 2.7 Ω , 2 W

Figure 4. 28 MHz Test Circuit

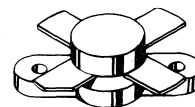
PT9798

The RF Line
SSB Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 30 MHz frequency range.

- Designed for Class A, AB or C Power Amplifiers
- Specified 50 Volt, 28 MHz Characteristics:
Output Power — 75 Watts
Power Gain — 15 dB Min
- 100% Tested for Load Mismatch at all Phase Angles with $\infty:1$ VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

15 dB
2-30 MHz
75 WATTS
50 VOLT
RF POWER
TRANSISTOR



.380 SOE F
CASE 211-07, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	55	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	150 1	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	55	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	110	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	70	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 50\text{ V}$, $P_{out} = 75\text{ W}$, $f = 28\text{ MHz}$)	G_{PE}	15	—	—	dB
Load Mismatch ($V_{CE} = 50\text{ V}$, $P_{out} = 75\text{ W PEP}$, $f = 28\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion ($V_{CE} = 50\text{ Vdc}$, $P_{out} = 75\text{ W}$, $f = 28\text{ MHz}$)	IMD	—	—	-32	dB

TYPICAL CHARACTERISTICS

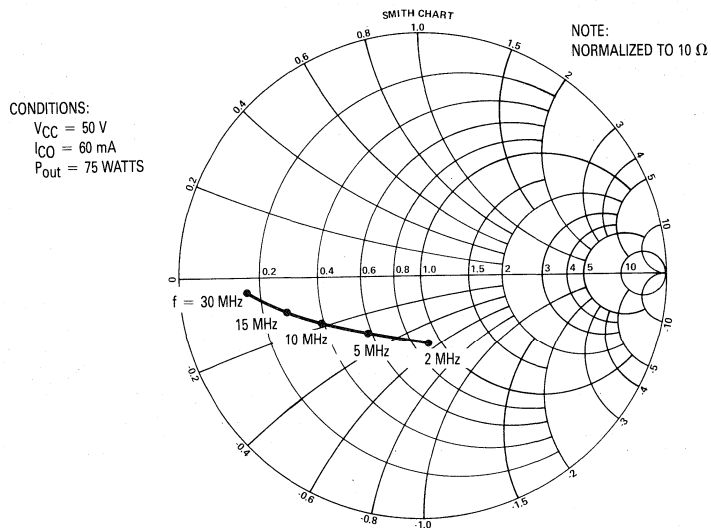


Figure 1. Series Equivalent Input Impedance

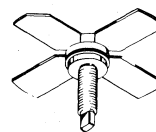
The RF Line UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages to 1 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
Output Power — 1.5 Watts
Power Gain — 8 dB Min, Class AB
- Gold Metallization for Improved Reliability

RF1029

**8 dB
TO 1 GHz
1.5 WATTS
LINEAR
UHF POWER
TRANSISTOR**



**.280 SOE
CASE 244C-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	14.5 0.084	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	12	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 25\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 250\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	80	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	4.75	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 25\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 900\text{ MHz}$, $I_C = 0.2\text{ A}$)	GPE	8	9.3	—	dB
Load Mismatch ($V_{CE} = 25\text{ V}$, $I_C = 0.2\text{ A}$, $P_{out} = 1.5\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

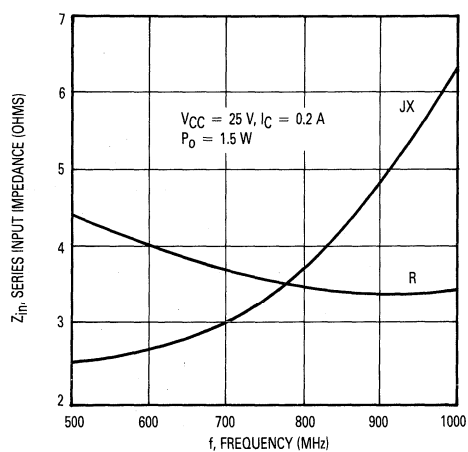


Figure 1. Input Impedance versus Frequency

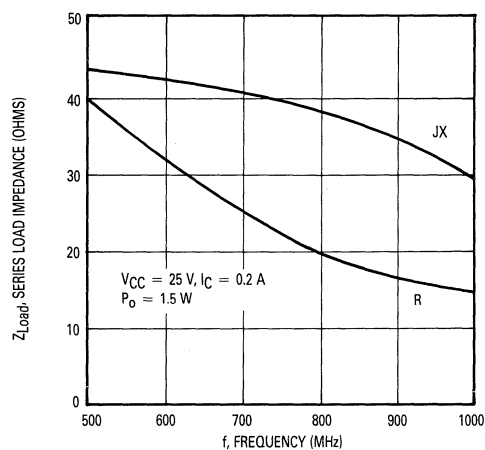


Figure 2. Load Impedance versus Frequency

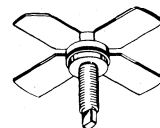
RF1030

The RF Line
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages to 1 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
Output Power — 3 Watts
Power Gain — 7.5 dB Min, Class AB
- Gold Metallization for Improved Reliability

**7.5 dB
TO 1 GHz
3 WATTS
LINEAR
UHF POWER
TRANSISTOR**



**.280 SOE
CASE 244C-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V _{CEO}	30	Vdc
Collector-Base Voltage	V _{CBO}	60	Vdc
Emitter-Base Voltage	V _{EBO}	4	Vdc
Total Device Dissipation @ T _C = 25°C Derate above 25°C	P _D	29 0.167	Watts W/°C
Operating Junction Temperature	T _J	200	°C
Storage Temperature Range	T _{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T _C = 70°C)	R _{θJC}	6	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage (I _C = 15 mA, I _B = 0)	V _{(BR)CEO}	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I _C = 15 mA, V _{BE} = 0)	V _{(BR)CES}	60	—	—	Vdc
Collector-Base Breakdown Voltage (I _C = 15 mA, I _E = 0)	V _{(BR)CBO}	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I _E = 5 mA, I _C = 0)	V _{(BR)EBO}	4	—	—	Vdc
Collector Cutoff Current (V _{CB} = 25 V, I _E = 0)	I _{CBO}	—	—	2	mAdc

ON CHARACTERISTICS

DC Current Gain (I _C = 500 mA, V _{CE} = 5 V)	h _{FE}	20	—	80	—
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DYNAMIC CHARACTERISTICS

Output Capacitance (V _{CB} = 28 V, I _E = 0, f = 1 MHz)	C _{ob}	—	—	9.8	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 25\text{ V}$, $P_{out} = 3\text{ W}$, $f = 900\text{ MHz}$, $I_C = 0.4\text{ A}$)	GPE	7.5	8.5	—	dB
Load Mismatch ($V_{CE} = 25\text{ V}$, $I_C = 0.4\text{ A}$, $P_{out} = 3\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

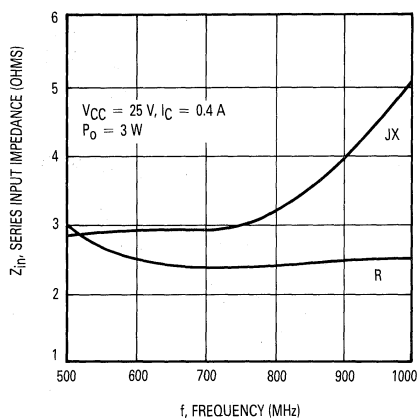


Figure 1. Input Impedance versus Frequency

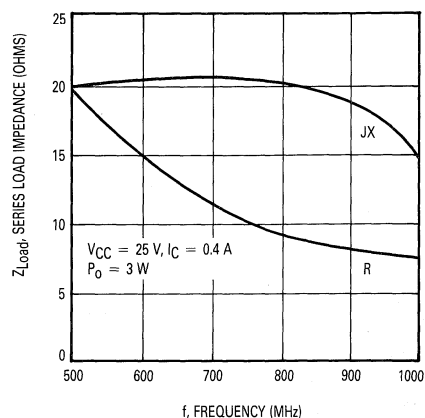


Figure 2. Load Impedance versus Frequency

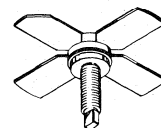
RF1031

The RF Line
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages to 1 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
Output Power — 4.5 Watts
Power Gain — 7 dB Min, Class AB
- Gold Metallization for Improved Reliability

**7 dB
TO 1 GHz
4.5 WATTS
LINEAR
UHF POWER
TRANSISTOR**



**280 SOE
CASE 244C-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CE}	30	Vdc
Collector-Base Voltage	V_{CB}	60	Vdc
Emitter-Base Voltage	V_{EB}	4	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 0.286	Watts $\text{W}/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	3.5	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20 \text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20 \text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 25 \text{ V}$, $I_E = 0$)	I_{CBO}	—	—	2.5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1 \text{ A}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	80	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	—	14	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 25\text{ V}$, $P_{out} = 4.5\text{ W}$, $f = 900\text{ MHz}$, $I_C = 0.6\text{ A}$)	G_{PE}	7	8	—	dB
Load Mismatch ($V_{CE} = 25\text{ V}$, $I_C = 0.6\text{ A}$, $P_{out} = 4.5\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

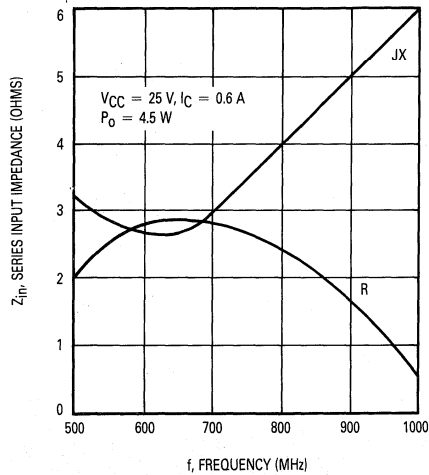


Figure 1. Input Impedance versus Frequency

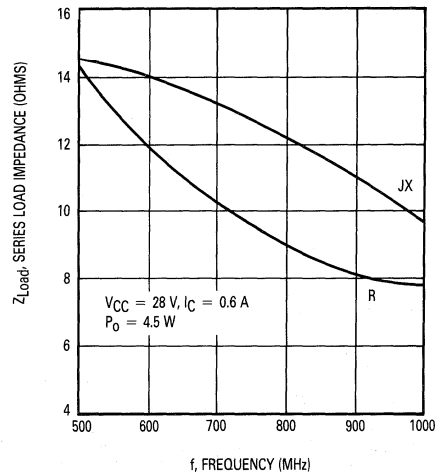


Figure 2. Load Impedance versus Frequency

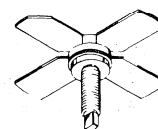
RF1032

The RF Line
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages to 1 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
Output Power — 6 Watts
Power Gain — 6.5 dB Min, Class AB
- Gold Metallization for Improved Reliability

**6.5 dB
TO 1 GHz
6 WATTS
LINEAR
UHF POWER
TRANSISTOR**



**.280 SOE
CASE 244C-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 0.286	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	3.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 25\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	3	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	80	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	19.5	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 25\text{ V}$, $P_{out} = 6\text{ W}$, $f = 900\text{ MHz}$, $I_C = 0.85\text{ A}$)	G_{PE}	6.5	7.5	—	dB
Load Mismatch ($V_{CE} = 25\text{ V}$, $P_{out} = 6\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

The RF Line

VHF Power Transistors

... designed primarily for portable radio applications requiring low battery voltage. These parts have been designed and characterized for operation in the frequency range of 66–88 MHz.

- 88 MHz
- 1.5 W — P_{out}
- 7.5 V — V_{CC}
- 13 dB Gain

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1.7	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	17.5 0.1	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{EB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $f = 1\text{ MHz}$)	C_{ob}	—	13	17	pF
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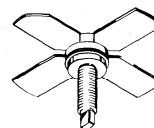
FUNCTIONAL TESTS

Output Power ($V_{CE} = 7.5\text{ V}$, $f = 88\text{ MHz}$, $P_{in} = 0.075\text{ W}$)	P_{out}	1.5	—	—	W
Collector Efficiency ($V_{CE} = 7.5\text{ V}$, $f = 88\text{ MHz}$, $P_{out} = 1.5\text{ W}$)	η_c	50	—	—	%
Output Mismatch Stress ($V_{CE} = 7.5\text{ V}$, $f = 88\text{ MHz}$, $P_{out} = 1.5\text{ W}$, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

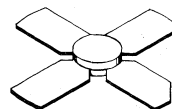
(continued)

TP212 TP212S

1.5 W — 88 MHz
VHF POWER TRANSISTORS
NPN SILICON



.280 SOE
CASE 244C-01, STYLE 1
TP212



.280 SOE S
CASE 249A-01, STYLE 1
TP212S

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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FUNCTIONAL DATA

Input Impedance, Common Emitter Amplifier ($V_{CE} = 7.5 \text{ V}$, $f = 88 \text{ MHz}$, $P_{in} = 0.075 \text{ W}$)	Z_{in}	$2.54 - j3.5 \text{ (Typ) Ohms}$			
Load Impedance, Common Emitter Amplifier ($V_{CE} = 7.5 \text{ V}$, $f = 88 \text{ MHz}$, $P_{out} = 1.5 \text{ W}$)	Z_{Load}	$21.38 + j10.3 \text{ (Typ) Ohms}$			

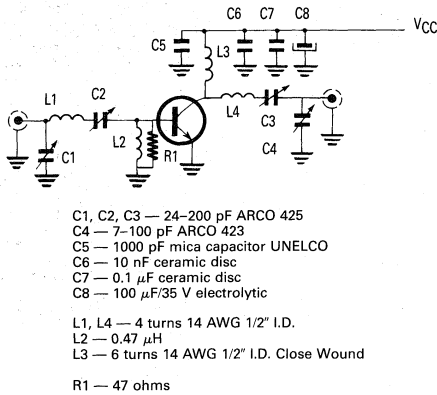


Figure 1. 88 MHz Test Circuit

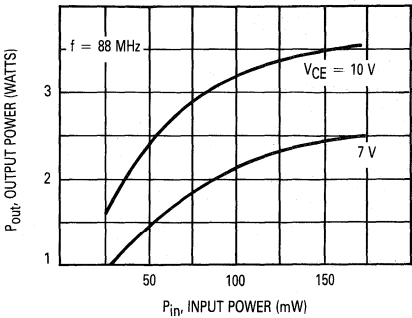


Figure 2. Output Power versus Input Power

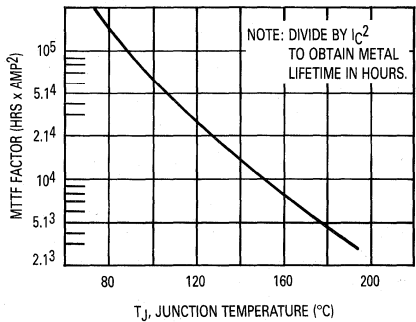


Figure 3. MTTF Factor versus Junction Temperature

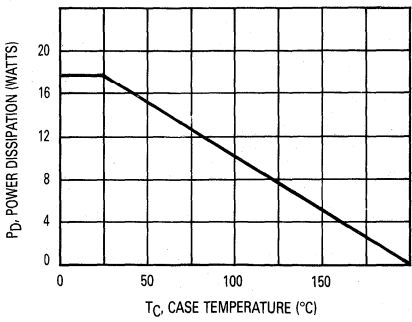


Figure 4. Power Dissipation versus Case Temperature

The RF Line

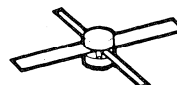
UHF Power Transistor

... designed primarily for portable radio applications requiring low battery voltage. These parts have been designed and characterized for operation in the frequency range of 400–512 MHz.

- 400–512 MHz
- 0.2 W — P_{out}
- 7.5 V — V_{CC}
- 13 dB Gain
- Gold Metallization for Reliability

TP251

200 mW — 512 MHz
UHF POWER TRANSISTOR
NPN SILICON



.200 SOE
CASE 305C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	0.2	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	2.9 0.02	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	– 65 to + 200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	60	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 5 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 2 \text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 50 \text{ mA}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	1.6	2.5	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 7.5\text{ V}$, $P_{out} = 175\text{ mW}$, $f = 470\text{ MHz}$, $I_Q = 10\text{ mA}$)	G_{PE1}	12.4	—	—	dB
Common-Emitter Amplifier Power Gain ($V_{CE} = 9.6\text{ V}$, $P_{out} = 200\text{ mW}$, $f = 470\text{ MHz}$, $I_Q = 10\text{ mA}$)	G_{PE2}	13	—	—	dB
Collector Efficiency ($V_{CE} = 7.5\text{ V}$, $P_{out} = 175\text{ mW}$, $f = 470\text{ MHz}$, $I_Q = 10\text{ mA}$)	η_c	35	40	—	%
Input Impedance, Common Emitter (Typ) ($V_{CE} = 7.5\text{ V}$, $I_Q = 10\text{ mA}$, $P_{out} = 175\text{ mW}$, $f = 470\text{ MHz}$)	$Z_{in} = 5 + j0.5\text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 7.5\text{ V}$, $I_Q = 10\text{ mA}$, $P_{out} = 175\text{ mW}$, $f = 470\text{ MHz}$)	$Z_{Load} = 47 + j45\text{ Ohms}$				

TYPICAL CHARACTERISTICS

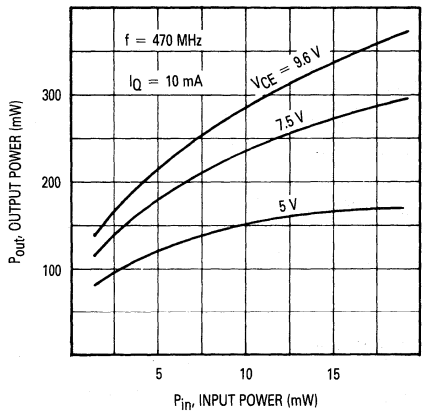


Figure 1. Output Power versus Input Power

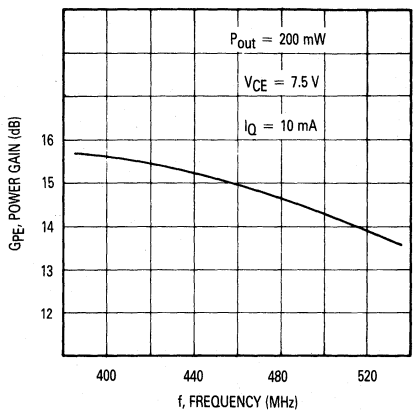


Figure 2. Power Gain versus Frequency

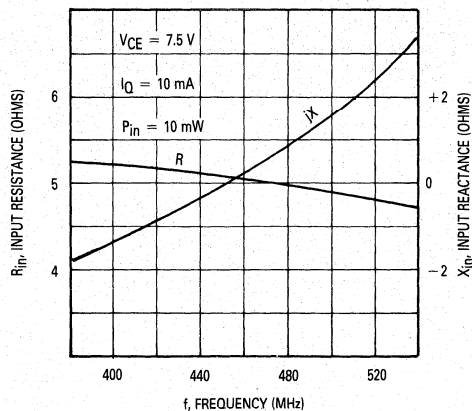


Figure 3. Input Impedance versus Frequency

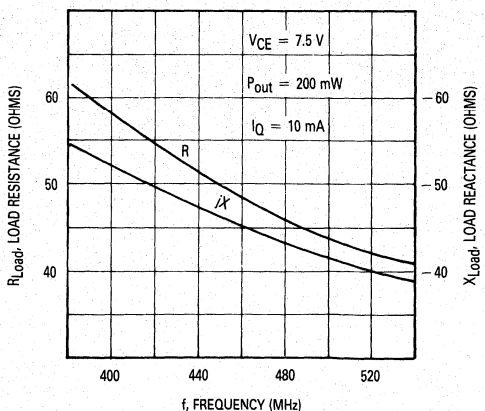
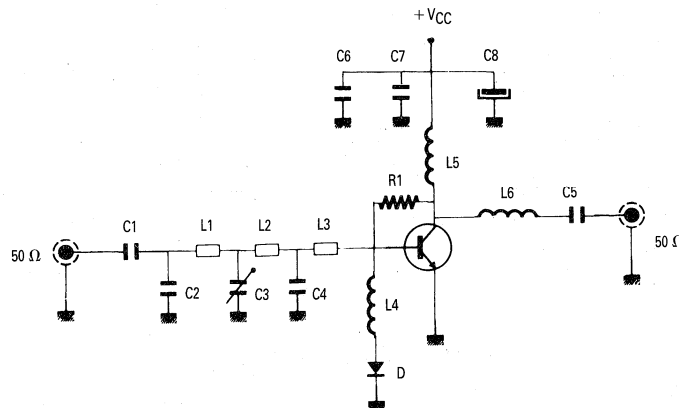


Figure 4. Output Impedance versus Frequency



C1 — 27 pF Ceramic 632 RTC
 C2 — 8.2 pF Ceramic 632 RTC
 C3 — 3–20 pF Trimmer Capacitor
 C4 — 22 pF Ceramic 632 RTC
 C5, C6 — 1000 pF Ceramic 629 RTC
 C7 — 10 nF Ceramic 629 RTC
 C8 — 10 μ F/25 V Electrolytic

L1 — Stripline $Z_0 = 70$ ohms $I = 0.061$ A
 L2 — Stripline $Z_0 = 70$ ohms $I = 0.026$ A $f_{ref} = 480$ MHz
 L3 — Stripline $Z_0 = 50$ ohms $I = 0.031$ A

L4, L5 — 0.15 μ H Molded Coil
 L6 — 3 turns, Silvered Wire 6/10 mm, 4 mm I.D., 8 mm length

R1 — 510 Ω Carbon Composition 1/4 W

Figure 5. 400–512 MHz Test Circuit

The RF Line

UHF Power Transistors

... designed for 5 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment.

- 470 MHz
- 1.5 W — P_{out}
- 7.5 V — V_{CC}
- High Gain — 10 dB Typ @ 470 MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Collector-Base Voltage	V_{CES}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	12 0.07	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 8\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 9\text{ V}$, $I_B = 0$)	I_{CEO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	80	—	190	—
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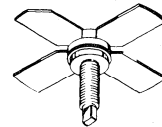
DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	7	9	pF
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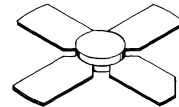
(continued)

TP254
TP254S

1.5 W — 470 MHz
UHF POWER
TRANSISTORS



.280 SOE S
CASE 244C-01, STYLE 1
TP254



.280 SOE S
CASE 249A-01, STYLE 1
TP254S

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 7.5\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 470\text{ MHz}$)	GPE	9.4	10.1	—	dB
Collector Efficiency ($V_{CE} = 7.5\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 470\text{ MHz}$)	η_c	50	60	—	%
Load Mismatch ($V_{CE} = 10\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 470\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

2

TYPICAL CHARACTERISTICS

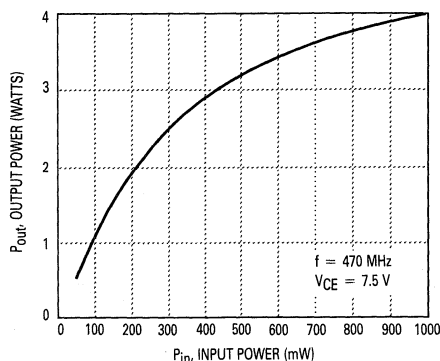


Figure 1. Output Power versus Input Power

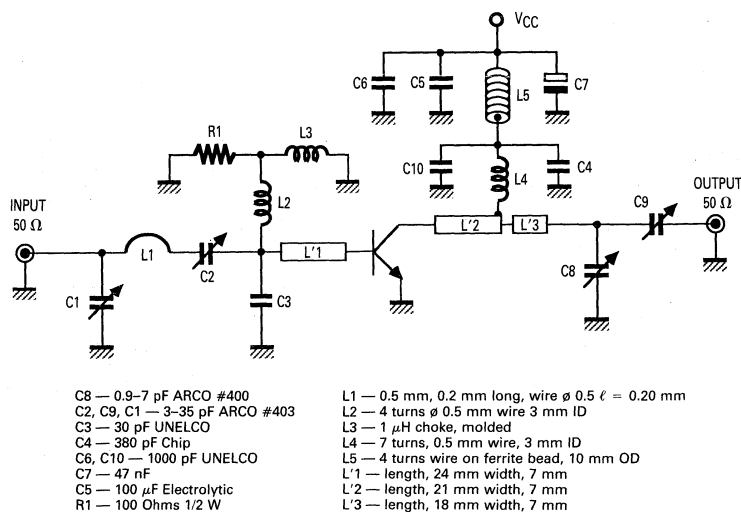


Figure 2. Test Circuit

The RF Line

UHF Power Transistors

... designed for 5 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 820 to 960 MHz frequency band. The TP301S is ideally suited for portable radio applications where low voltage and high packaging density are required.

- 900 MHz
- 0.8 W — P_{out}
- 9.6 V — V_{CC}
- High Gain — 9.5 dB Typ @ 900 MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Collector-Base Voltage	V_{CBO}	24	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	0.75	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	24	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 2\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	24	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 9\text{ V}$, $I_B = 0$)	I_{CEO}	—	—	0.6	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	60	—	190	—
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DYNAMIC CHARACTERISTICS

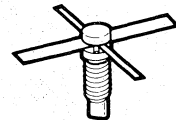
Output Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	4.5	pF
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FUNCTIONAL TESTS

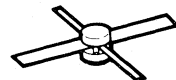
Common-Emitter Amplifier Power Gain ($V_{CE} = 9.6\text{ V}$, $P_{out} = 0.8\text{ W}$, $f = 900\text{ MHz}$)	G_{PE}	9.5	—	—	dB
Collector Efficiency ($V_{CE} = 9.6\text{ V}$, $P_{out} = 0.8\text{ W}$, $f = 900\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 0.8\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TP301
TP301S

0.8 W — 900 MHz
UHF POWER
TRANSISTORS



.200 SOE
CASE 305B-01, STYLE 1
TP301



.200 SOE S
CASE 305C-01, STYLE 1
TP301S

TYPICAL CHARACTERISTICS

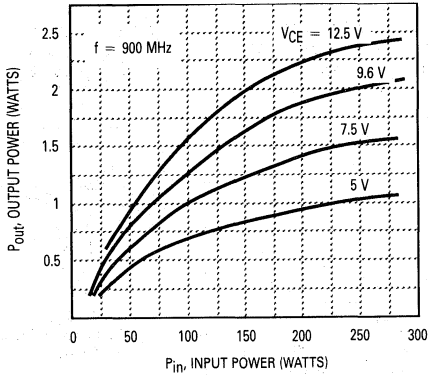
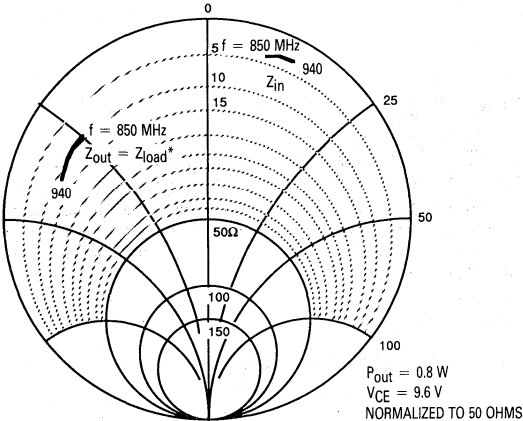
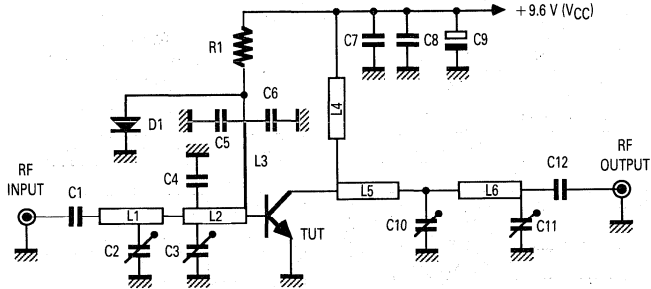


Figure 1. Output Power versus Input Power



f (MHz)	Z _{in} (Ohm)	Z _{out} (Ohm)
850	4 + j9	9 - j27
880	3.9 + j10.5	10 - j30
900	3.6 + j11	10 - j32
940	3.5 + j13	12 - j37

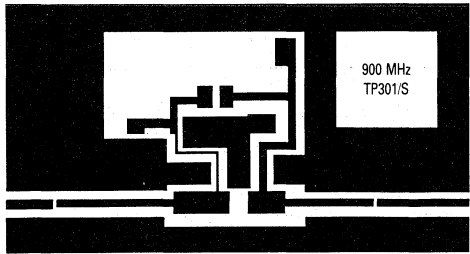
Figure 2. Series Equivalent Input/Output Impedances



- C1, C5, C7, C12 — Capacitor Chip 330 pF CGO SMT
- C2, C3, C10, C11 — 0.5–5 pF GKU Trimmer Capacitor
- C4 — Capacitor Chip 3.9 pF
- C6, C8 — Capacitor Chip 15 nF
- C9 — Electrolytic Capacitor 10 MF 16 V
- R1 — Resistor 1/2 x 270 Ohms 1/2 W
- D1 — 0.57 For Class B Operation
- L1 — 15 mm Z₀ = 50 Ohm
- L2, L5 — 7 mm Z₀ = 25 Ohm
- L3 — 27 mm Z₀ = 75 Ohm
- L4 — 20 mm Z₀ = 50 Ohm
- L6 — 28 mm Z₀ = 50 Ohm
- Board Material: .020 In., $\epsilon_r = 2.55$, Teflon Glass

Note: Amplifier tunable from 820 to 960 MHz.
Instantaneous Bandwidth — 40 MHz, Typ.

Figure 3. Broadband Amplifier Circuit



Note: The Printed Circuit Board shown is 75% of the original.
Board Material: .020 In. Glass Teflon $\epsilon_r = 2.55$

Figure 4. Printed Circuit Board Layout

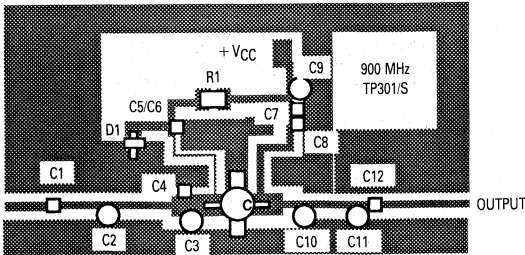


Figure 5. Component Layout

The RF Line

UHF Power Transistors

... designed for 5 to 10 Volt large-signal amplifier applications in industrial and commercial FM equipment operating in the 820 to 960 MHz frequency band. The TP301S is ideally suited for portable radio applications where low voltage and high packaging density are required.

- 900 MHz
- 2 W — P_{out}
- 9.6 V — V_{CC}
- High Gain — 7.5 dB Min @ 900 MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Collector-Base Voltage	V_{CBO}	24	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	1.3	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 4\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	24	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 9\text{ V}$, $I_B = 0$)	I_{CEO}	—	—	1.2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	60	—	190	—
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DYNAMIC CHARACTERISTICS

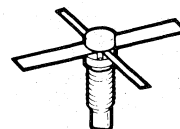
Output Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	9	pF
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FUNCTIONAL TESTS

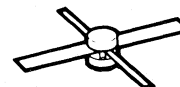
Common-Emitter Amplifier Power Gain ($V_{CE} = 9.6\text{ V}$, $P_{out} = 2\text{ W}$, $f = 900\text{ MHz}$)	G_{PE}	7.5	—	—	dB
Collector Efficiency ($V_{CE} = 9.6\text{ V}$, $P_{out} = 2\text{ W}$, $f = 900\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 2\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TP302 TP302S

2 W — 900 MHz
 UHF POWER
 TRANSISTORS



.200 SOE
 CASE 305B-01, STYLE 1
 TP302



.200 SOE S
 CASE 305C-01, STYLE 1
 TP302S

TYPICAL CHARACTERISTICS

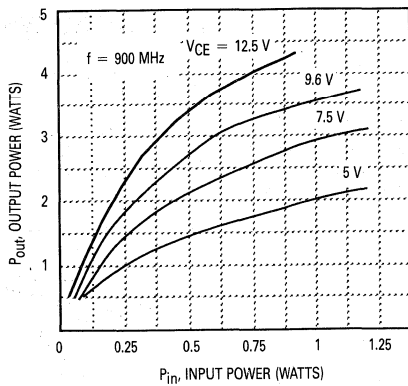
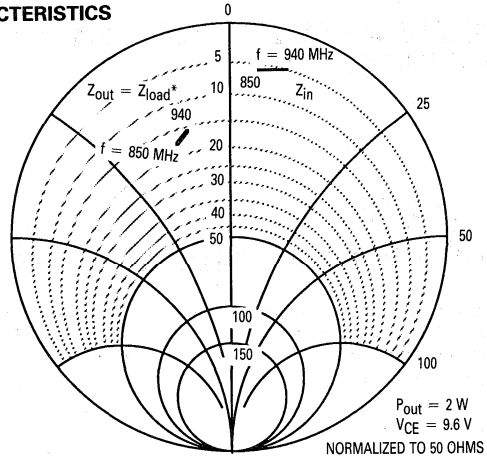
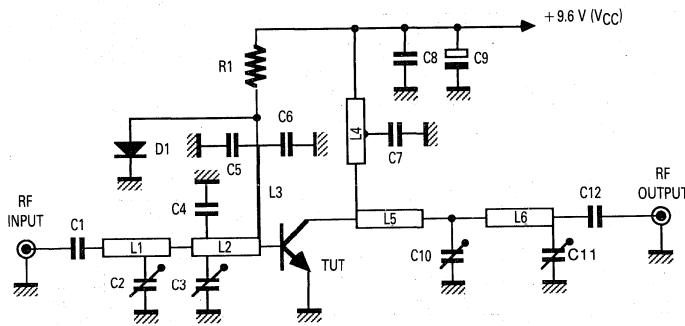


Figure 1. Output Power versus Input Power



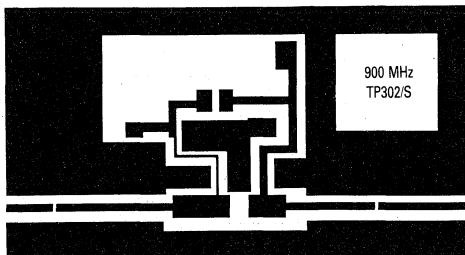
f (MHz)	Z _{in} (Ohm)	Z _{out} (Ohm)
850	6.9 + j3.9	17.6 - j12.7
880	6.4 + j4.7	17.3 - j11.8
900	6 + j5.6	17.1 - j11.5
940	5.6 + j7.4	16.6 - j10.3

Figure 2. Series Equivalent Input/Output Impedances



C1, C5, C7, C12 — Capacitor Chip 330 pF CGO SMT
 C2, C3, C10, C11 — 0.5–5 pF GKU Trimmer Capacitor
 C4 — Capacitor Chip 3.9 pF
 C6, C8 — Capacitor Chip 15 nF
 C9 — Electrolytic Capacitor 10 MF 16 V
 R1 — Resistor // 2 x 270 Ohms 1/2 W
 D1 — 0.57 for Class B Operation
 L1 — 15 mm Z₀ = 50 Ohm
 L2, L5 — 7 mm Z₀ = 25 Ohm
 L3 — 27 mm Z₀ = 75 Ohm
 L4 — 10 mm Z₀ = 50 Ohm
 L6 — 13 mm Z₀ = 50 Ohm
 Board Material: .020 In., $\epsilon_r = 2.55$, Teflon Glass
 Note: Amplifier tunable from 820 to 960 MHz.
 Instantaneous Bandwidth — 40 MHz, Typ.

Figure 3. Broadband Amplifier Circuit



Board Material: .020 In. Glass Teflon $\epsilon_r = 2.55$

Figure 4. Printed Circuit Board Layout (Not to Scale)

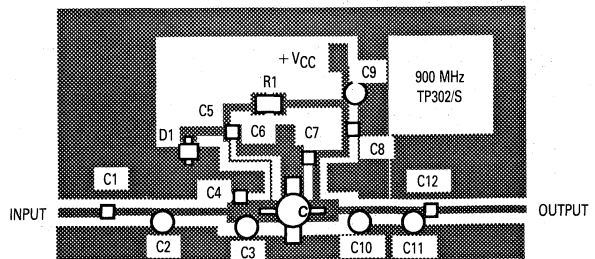


Figure 5. Component Layout

The RF Line UHF Power Transistors

... designed for 5 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 820 to 960 MHz frequency band. The TP303S is ideally suited for portable radio applications where low voltage and high packaging density are required.

- 900 MHz
- 3 W — P_{out}
- 9.6 V — V_{CC}
- High Gain — 7 dB Min @ 900 MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Collector-Base Voltage	V_{CBO}	24	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	1.6	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	9	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 8\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	24	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 9\text{ V}$, $I_B = 0$)	I_{CEO}	—	—	2.4	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	60	—	190	—
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DYNAMIC CHARACTERISTICS

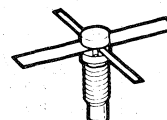
Output Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	18	pF
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FUNCTIONAL TESTS

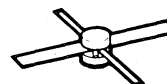
Common-Emitter Amplifier Power Gain ($V_{CE} = 9.6\text{ V}$, $P_{out} = 3\text{ W}$, $f = 900\text{ MHz}$)	G_{PE}	7	—	—	dB
Collector Efficiency ($V_{CE} = 9.6\text{ V}$, $P_{out} = 3\text{ W}$, $f = 900\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 3\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TP303
TP303S

3 W — 900 MHz
UHF POWER
TRANSISTORS



.200 SOE
CASE 305B-01, STYLE 1
TP303



.200 SOE S
CASE 305C-01, STYLE 1
TP303S

TYPICAL CHARACTERISTICS

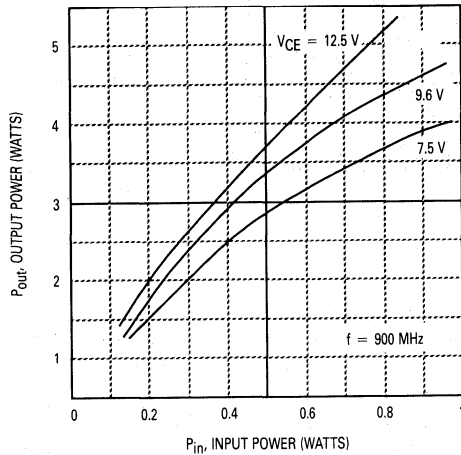
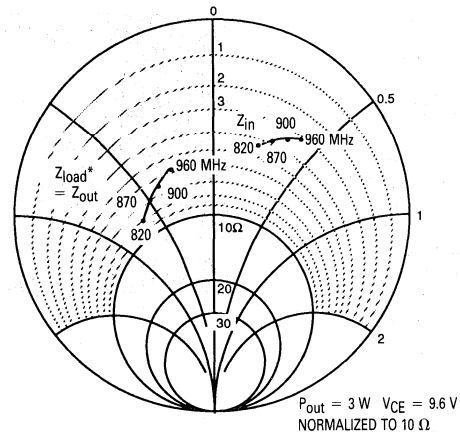
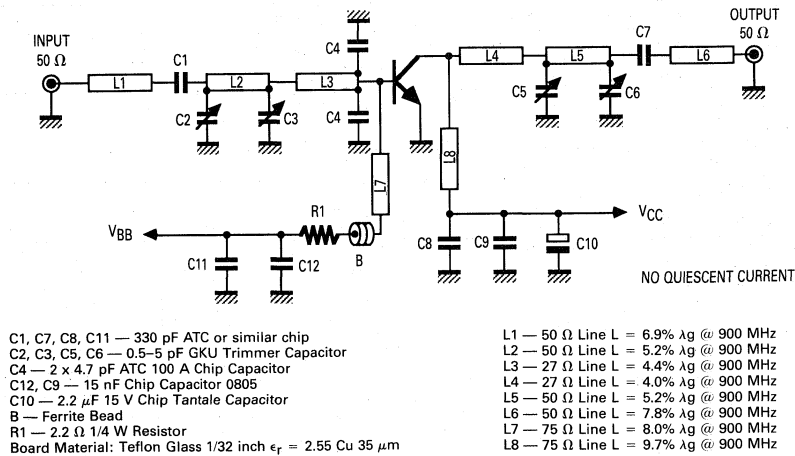


Figure 1. Output Power versus Input Power



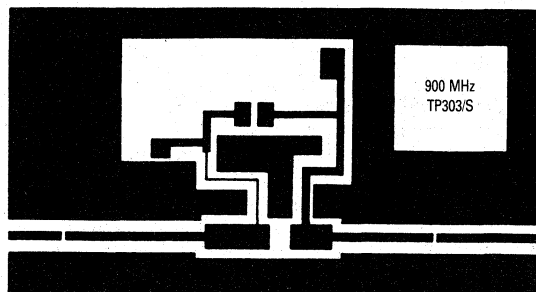
f (MHz)	Z_{in} (Ohm)	Z_{out} (Ohm)
820	$4.5 + j2$	$8.8 - j6.75$
870	$4.1 + j2.7$	$7 - j5$
900	$3.8 + j3.7$	$6.5 - j4$
960	$3.2 + j4.3$	$5.7 - j2.75$

Figure 2. Series Equivalent Input/Output Impedances



Note: Amplifier tunable from 820 to 960 MHz.
Instantaneous Bandwidth — 40 MHz, Typ.

Figure 3. Broadband Amplifier Circuit



Note: The Printed Circuit Board shown is 75% of the original.

Board Material: .020 In. Glass Teflon $\epsilon_r = 2.55$

Figure 4. Printed Circuit Board Layout

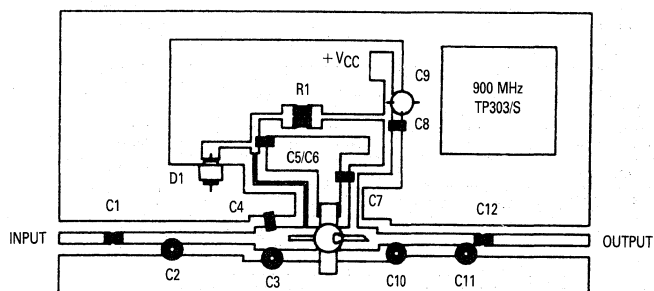


Figure 5. Component Layout

The RF Line

UHF Power Transistors

2

... designed for 5 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 820 to 960 MHz frequency band. The TP304S is ideally suited for portable radio applications where low voltage and high packaging density are required.

- 900 MHz
- 5 W — P_{out}
- 9.6 V — V_{CC}
- High Gain — 6 dB Min @ 900 MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Collector-Base Voltage	V_{CBO}	24	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	6	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 8\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	24	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 9\text{ V}$, $I_B = 0$)	I_{CEO}	—	—	2.4	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	60	—	190	—
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DYNAMIC CHARACTERISTICS

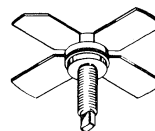
Output Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	18	pF
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FUNCTIONAL TESTS

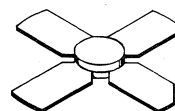
Common-Emitter Amplifier Power Gain ($V_{CE} = 9.6\text{ V}$, $P_{out} = 5\text{ W}$, $f = 900\text{ MHz}$)	G_{PE}	6	—	—	dB
Collector Efficiency ($V_{CE} = 9.6\text{ V}$, $P_{out} = 5\text{ W}$, $f = 900\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 5\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TP304
TP304S

5 W — 900 MHz
UHF POWER
TRANSISTORS



.280 SOE
CASE 244C-01, STYLE 1
TP304



.280 SOE S
CASE 249A-01, STYLE 1
TP304S

TYPICAL CHARACTERISTICS

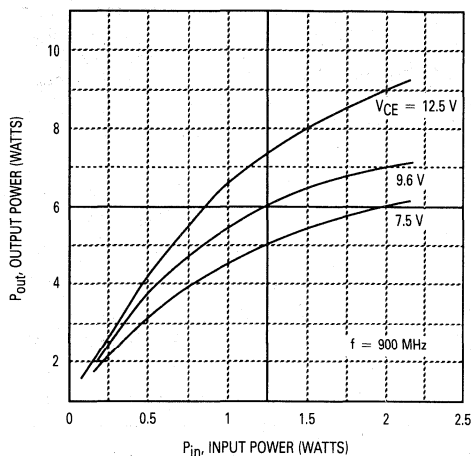
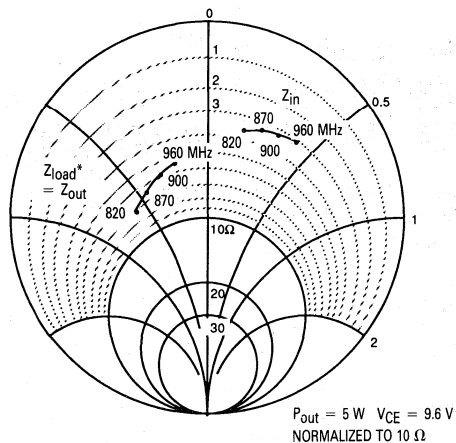
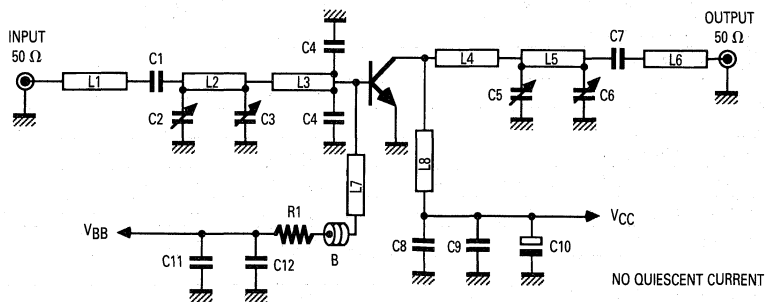


Figure 1. Output Power versus Input Power



f (MHz)	Z _{in} (Ohm)	Z _{out} (Ohm)
820	3.5 + j1.5	7.3 - j6
870	3.4 + j2.2	6.5 - j4.5
900	3.3 + j3.2	5.8 - j3.2
960	3 + j4.1	5.5 - j2

Figure 2. Series Equivalent Input/Output Impedances



C1, C7, C8, C11 — 330 pF ATC or similar chip
 C2, C3, C5, C6 — 0.5–5 pF GKU Trimmer Capacitor
 C4 — 2 x 4.7 pF ATC 100 A Chip Capacitor
 C12, C9 — 15 nF Chip Capacitor 0805
 C10 — 2.2 μF 15 V Chip Tantale Capacitor
 B — Ferrite Bead
 R1 — 2.2 Ω 1/4 W Resistor
 Board Material: Teflon Glass 1/32 inch $\epsilon_r = 2.55$ Cu 35 μm

L1 — 50 Ω Line L = 6.9% λ_g @ 900 MHz
 L2 — 50 Ω Line L = 5.2% λ_g @ 900 MHz
 L3 — 27 Ω Line L = 4.4% λ_g @ 900 MHz
 L4 — 27 Ω Line L = 4.0% λ_g @ 900 MHz
 L5 — 50 Ω Line L = 5.2% λ_g @ 900 MHz
 L6 — 50 Ω Line L = 7.8% λ_g @ 900 MHz
 L7 — 75 Ω Line L = 8.0% λ_g @ 900 MHz
 L8 — 75 Ω Line L = 9.7% λ_g @ 900 MHz

Note: Amplifier tunable from 820 to 960 MHz.
 Instantaneous Bandwidth — 40 MHz, Typ.

Figure 3. Broadband Amplifier Circuit

Advance Information

The RF Line

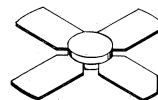
UHF Power Transistor

... designed for 5 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment.

- 470 MHz
- 4 W — P_{out}
- 7.5 V — V_{CC}
- Rugged

TP2007A

4 W — 470 MHz
UHF POWER
TRANSISTOR



.280 SOE S
CASE 249A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	3.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	44 0.25	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $V_{BE} = 0$)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	25	34	pF
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This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 7.5 \text{ V}$, $P_{out} = 4 \text{ W}$, $f = 470 \text{ MHz}$)	G_{PE}	4.2	—	—	dB
Collector Efficiency ($V_{CE} = 7.5 \text{ V}$, $P_{out} = 4 \text{ W}$, $f = 470 \text{ MHz}$)	η_c	50	55	—	%
Load Mismatch ($V_{CE} = 10 \text{ V}$, $P_{out} = 4 \text{ W}$, $f = 470 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

Advance Information

The RF Line

VHF Power Transistor

The TP2031 has been specifically designed and characterized for 12.5 V operation in 225 MHz amplifiers.

Its grounded emitter configuration gives excellent thermal dissipation and provides a good RF screen.

This device features high gain and an infinite VSWR rating at all phase angles and at rated output power.

- 225 MHz
- 4 W — P_{out}
- 12.5 V — V_{CC}
- Rugged

TP2031

**4 W — 225 MHz
VHF POWER
TRANSISTOR**



**TO-39GE
CASE 79-04, STYLE 5**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	8 0.05	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10 \text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15 \text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200 \text{ mA}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	20	40	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	12	15	pF
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This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 3.5\text{ W}$, $f = 225\text{ MHz}$)	G_{PE}	10.6	11.2	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 3.5\text{ W}$, $f = 225\text{ MHz}$)	η_c	50	55	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 3.5\text{ W}$, $f = 225\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 3.5\text{ W}$, $f = 225\text{ MHz}$)	$Z_{in} = 4.2 - j3\text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 3.5\text{ W}$, $f = 225\text{ MHz}$)	$Z_{load} = 15.5 + j3.3\text{ Ohms}$				

Advance Information

The RF Line

UHF Power Transistors

2

The TP2032/F has been specially designed and characterized for 12.5 V operation in 225 MHz amplifiers.

It can be operated under Class B or C and is able to withstand infinite VSWR at all phase angles at rated output power.

- 225 MHz
- 10 W — P_{out}
- 12.5 V — V_{CC}
- Rugged

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	3.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 0.29	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	25	30	pF
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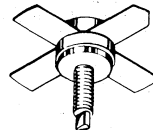
FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 225\text{ MHz}$)	G_{PE}	8.25	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 225\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 225\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 225\text{ MHz}$)		$Z_{in} = 1.6 + j0.1\text{ Ohms}$			
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 225\text{ MHz}$)		$Z_{load} = 7.5 + j2.1\text{ Ohms}$			

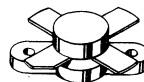
This document contains information on a new product. Specifications and information herein are subject to change without notice.

TP2032 TP2032F

10 W — 225 MHz
UHF POWER
TRANSISTORS



.380 SOE
CASE 145D-01, STYLE 1
TP2032



.380 SOE F
CASE 211-07, STYLE 1
TP2032F

Advance Information

The RF Line

VHF Power Transistor

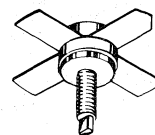
The TP2033 has been specifically designed and characterized for 12.5 V operation in 225 MHz high power amplifiers.

Its construction which incorporates gold metallization and diffused ballast resistors enables the part to withstand infinite VSWR at all phase angles at rated output power. It can be operated under Class A, B or C.

- 30 W
- High Gain
 - 10 dB Min @ 175 MHz
 - 9 dB Min @ 225 MHz
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

TP2033

30 W — 225 MHz
VHF POWER
TRANSISTOR



.380 SOE
CASE 145D-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	80 0.46	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	70	100	pF
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This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 30 \text{ W}$, $f = 225 \text{ MHz}$)	G_{PE1}	9	—	—	dB
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 30 \text{ W}$, $f = 175 \text{ MHz}$)	G_{PE2}	10	—	—	dB
Collector Efficiency ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 30 \text{ W}$, $f = 225 \text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 30 \text{ W}$, $f = 225 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 30 \text{ W}$, $f = 225 \text{ MHz}$)	$Z_{in} = 1.05 + j0.6 \text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 30 \text{ W}$, $f = 225 \text{ MHz}$)	$Z_{load} = 2.5 + j0.15 \text{ Ohms}$				

Advance Information
The RF Line
UHF Power Transistors

The TP2034/F has been specially designed and characterized for 12.5 V operation in 225 MHz high power amplifiers.

Its construction which incorporates gold metallization and diffused ballast resistors enables the part to withstand infinite VSWR at all phase angles at rated output power. It can be operated under Class A, B or C.

- 225 MHz
- 40 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	80 0.46	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	70	100	pF
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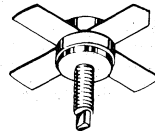
FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 35\text{ W}$, $f = 225\text{ MHz}$)	G_{PE}	5.45	6	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 35\text{ W}$, $f = 225\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 40\text{ W}$, $f = 225\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 40\text{ W}$, $f = 225\text{ MHz}$)	$Z_{in} = 1.4 + j1.8\text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 40\text{ W}$, $f = 225\text{ MHz}$)	$Z_{load} = 2.1 + j0.1\text{ Ohms}$				

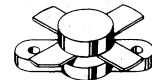
This document contains information on a new product. Specifications and information herein are subject to change without notice.

TP2034
TP2034F

40 W — 225 MHz
UHF POWER
TRANSISTORS



.380 SOE
CASE 145D-01, STYLE 1
TP2034



.380 SOE F
CASE 211-07, STYLE 1
TP2034F

Advance Information

The RF Line

VHF Power Transistor

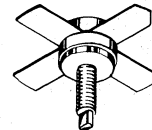
The TP2037 has been specifically designed and characterized for 12.5 V operation in 225 MHz high power amplifiers.

Its construction which incorporates gold metallization and diffused ballast resistors enables the part to withstand infinite VSWR at all phase angles at rated output power. It can be operated under Class A, B or C.

- 225 MHz
- 35 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

TP2037

**35 W — 225 MHz
VHF POWER
TRANSISTOR**



**.380 SOE
CASE 145D-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	80 0.46	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	70	100	pF
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This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 35\text{ W}$, $f = 225\text{ MHz}$)	G_{PE}	8.9	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 35\text{ W}$, $f = 225\text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 40\text{ W}$, $f = 225\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 40\text{ W}$, $f = 225\text{ MHz}$)	$Z_{in} = 1 + j0.6\text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 40\text{ W}$, $f = 225\text{ MHz}$)	$Z_{load} = 2.6 + j0.13\text{ Ohms}$				

The RF Line

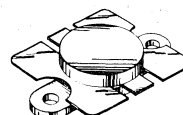
VHF Power Transistor

Designed for use in 12.5 V VHF amplifiers operating under Class A, B or C conditions. Its construction which incorporates gold metallization and diffused ballast resistors for longer life, enables the part to be used at its maximum ratings and be able to withstand an infinite VSWR at all phase angles.

- 88 MHz
- 80 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability
- Load Mismatch Capability at Rated Output Power

TP2180

80 W — 88 MHz
VHF POWER TRANSISTOR
NPN SILICON



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	140 0.8	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 200 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100 \text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 20 \text{ V}$, $I_E = 0$)	I_{CBO}	—	—	5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1 \text{ A}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	—	180	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V _{CE} = 12.5 V, P _{out} = 80 W, f = 88 MHz)	G _{PE}	7	—	—	dB
Collector Efficiency (V _{CE} = 12.5 V, P _{out} = 80 W, f = 88 MHz)	η _c	60	70	—	%
Load Mismatch (V _{CE} = 12.5 V, P _{out} = 80 W, f = 88 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) (V _{CE} = 12.5 V, P _{in} = 16 W, f = 88 MHz)	Z _{in} = 0.3 – j0.4 Ohms				
Load Impedance, Common Emitter (Typ) (V _{CE} = 12.5 V, P _{out} = 80 W, f = 88 MHz)	Z _{Load} = 0.6 – j0.44 Ohms				

TYPICAL CHARACTERISTICS

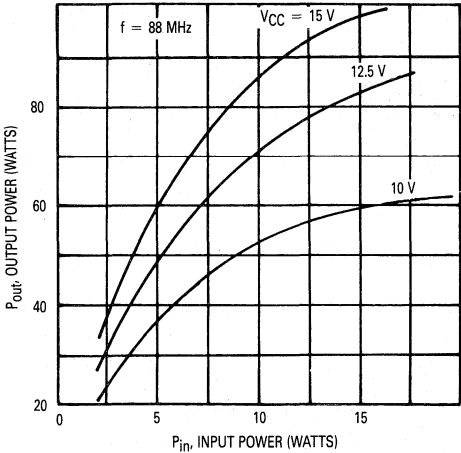


Figure 1. Output Power versus Input Power

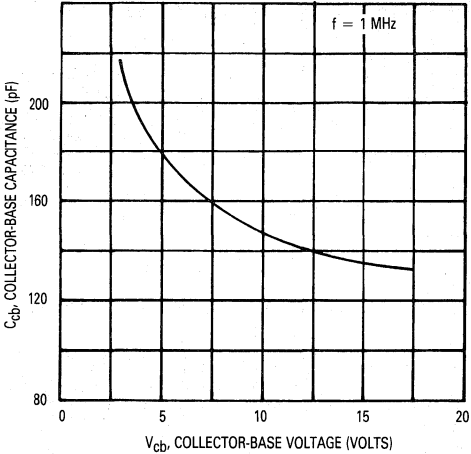


Figure 2. Collector-Base Capacitance versus Voltage

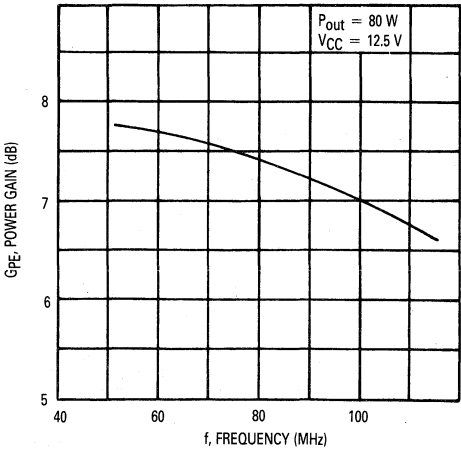


Figure 3. Power Gain versus Frequency

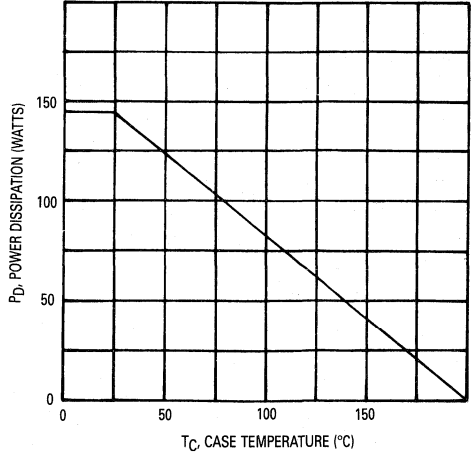
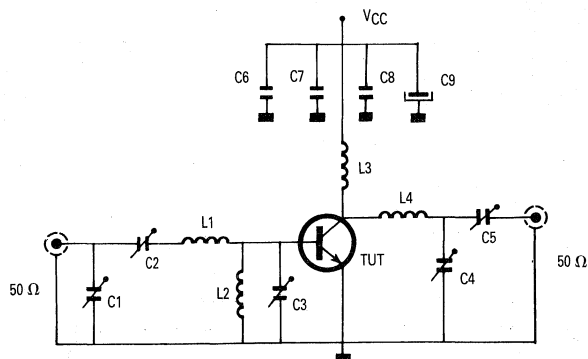


Figure 4. Power Dissipation Rating versus Temperature



C1, C4 — 24–200 pF trimmer capacitor ARCO 425
 C2, C3 — 55–300 pF trimmer capacitor ARCO 427
 C5 — 7–100 pF trimmer capacitor ARCO 423
 C6 — 1000 pF mica capacitor UNELCO
 C7 — 10 nF ceramic disc
 C8 — 0.1 μ F ceramic disc
 C9 — 470 μ F/40 V

L1 — 3 turns, 12/10 mm silvered wire, 5 mm I.D.
 L2 — 0.68 μ H molded coil
 L3 — 5 turns, 12/10 mm silvered wire, 12 mm I.D.
 L4 — 1 turn, 12/10 mm silvered wire, 6 mm I.D.

Figure 5. 88 MHz Test Circuit

TP2300

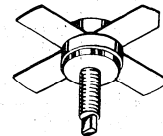
The RF Line
VHF Power Transistor

The TP2300 is designed for use in 12.5 V VHF amplifiers operating under Class A, B or C conditions.

Its construction which incorporates gold metallization and diffused ballast resistors enables the part to be used at its maximum ratings and be able to withstand an infinite VSWR at all phase angles.

- 175 MHz
- 4 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

4 W — 175 MHz
VHF POWER
TRANSISTOR



.380 SOE
CASE 145D-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1.7	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	35 0.2	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	12	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 175\text{ MHz}$)	η_c	55	—	—	%

TYPICAL CHARACTERISTICS

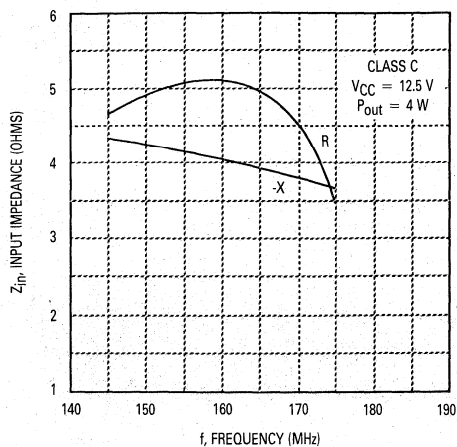


Figure 1. Input Series Impedance versus Frequency

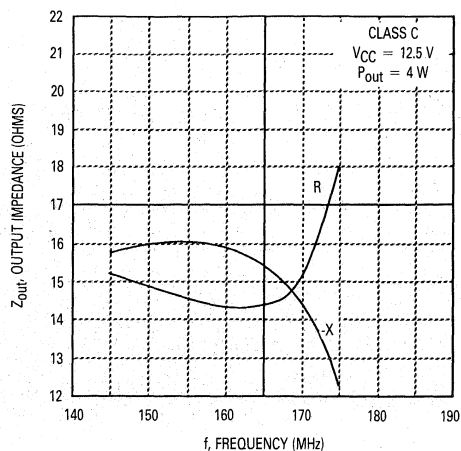


Figure 2. Output Series Impedance versus Frequency

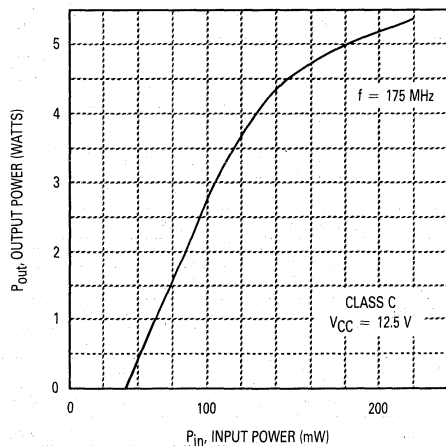


Figure 3. Output Power versus Input Power

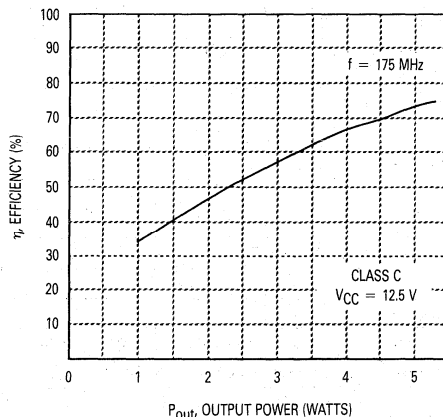


Figure 4. Collector Efficiency versus Output Power

TYPICAL CHARACTERISTICS

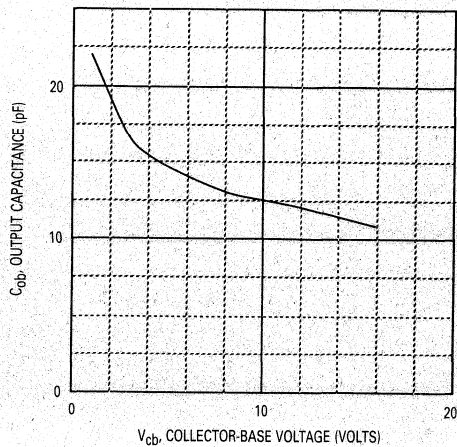
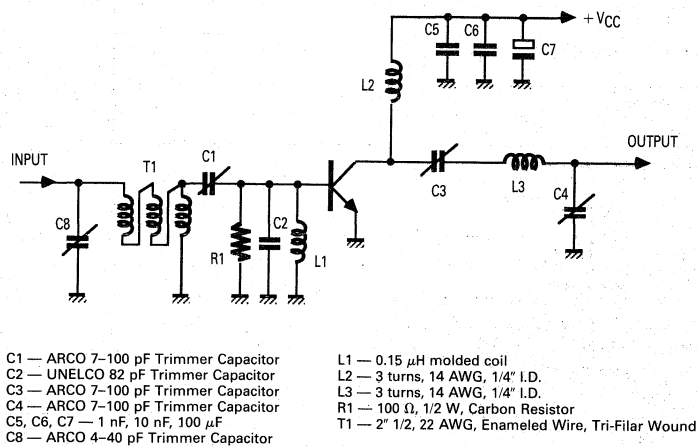


Figure 5. Output Capacitance versus Voltage



PC Board: Double Sided PC Board 0.06"

Figure 6. 175 MHz Test Circuit

The RF Line VHF Power Transistor

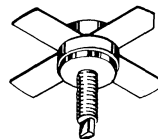
The TP2304 is designed for use in 12.5 V VHF amplifiers operating under Class A, B or C conditions.

Its construction which incorporates gold metallization and diffused ballast resistors for longer life, enables the part to be used at its maximum ratings and be able to withstand an infinite VSWR at all phase angles.

- 175 MHz
- 40 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

TP2304

**40 W — 175 MHz
VHF POWER
TRANSISTOR**



**.380 SOE
CASE 145D-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	80 0.46	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	70	100	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 40 \text{ W}$, $f = 175 \text{ MHz}$)	G_{PE1}	5.2	—	—	dB
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 40 \text{ W}$, $f = 88 \text{ MHz}$)	G_{PE2}	7	—	—	dB
Collector Efficiency ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 40 \text{ W}$, $f = 175 \text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 40 \text{ W}$, $f = 175 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{in} = 10 \text{ W}$, $f = 175 \text{ MHz}$)	$Z_{in} = 1.5 + j1.6 \text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 40 \text{ W}$, $f = 175 \text{ MHz}$)	$Z_{load} = 2.25 + j0.1 \text{ Ohms}$				

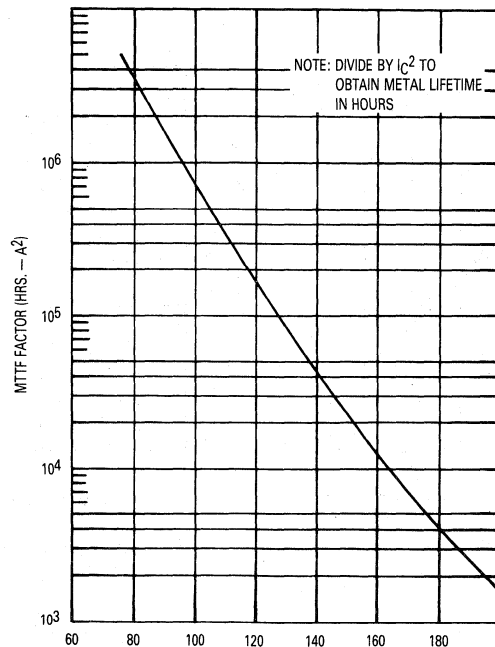


Figure 1. MTTF Factor versus Junction Temperature

TYPICAL CHARACTERISTICS

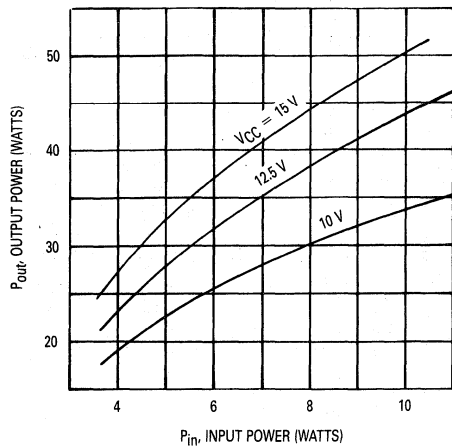


Figure 2. Output Power versus Input Power
 $f = 175 \text{ MHz}$

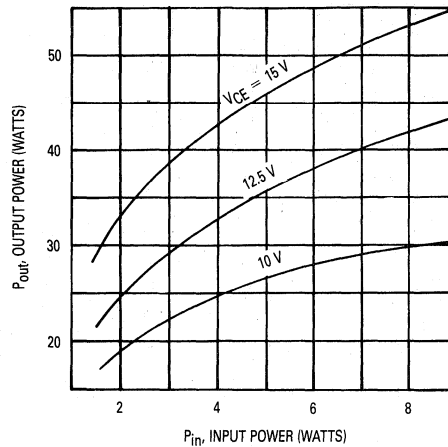


Figure 3. Output Power versus Input Power
 $f = 88 \text{ MHz}$

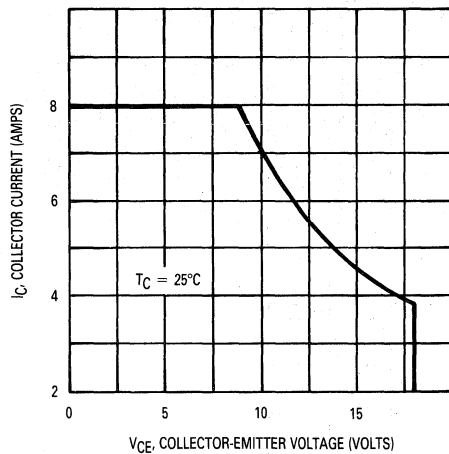


Figure 4. Safe Operating Area

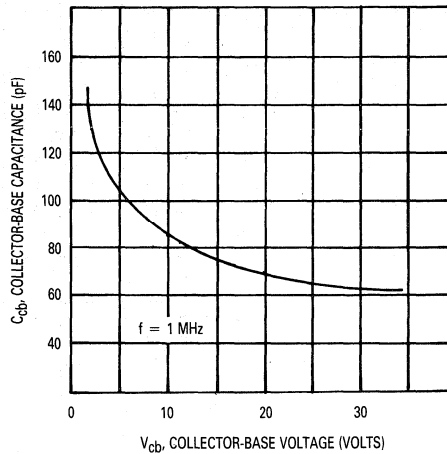
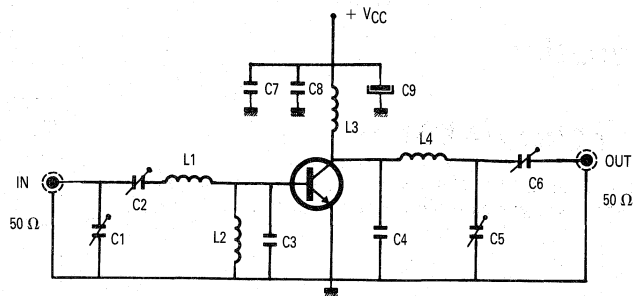


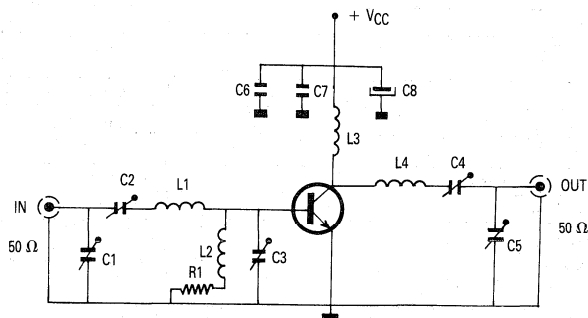
Figure 5. Collector Base Capacitance



C1 — ARCO 403 trimmer capacitor
 C2, C5 — ARCO 423 trimmer capacitor
 C3 — 200 pF mica capacitor UNELCO
 C4 — 150 pF mica capacitor UNELCO
 C6 — ARCO 425 trimmer capacitor
 C7 — 1000 pF mica capacitor UNELCO
 C8 — 0.1 μ F ceramic disc
 C9 — 47 μ F/63 V electrolytic

L1 — 3 turns 15/10 mm silvered wire 6 mm I.D.
 L2 — 0.47 μ H molded coil
 L3 — 6 turns 10/10 mm enameled wire wound on R1
 L4 — 1 turns 15/10 mm silvered wire 6 mm I.D.
 R1 — 380 ohms 2 W carbon composition

Figure 6. 175 MHz Test Circuit



C1, C4 — ARCO 425 24–200 pF trimmer capacitor
 C2 — ARCO 423 7–100 pF trimmer capacitor
 C3, C5 — ARCO 427 55–300 pF trimmer capacitor
 C6 — 1000 pF mica capacitor
 C7 — 10 nF ceramic
 C8 — 100 μ F/35 V electrolytic

L1 — 5 turns #14 AWG 3/8" I.D.
 L2 — 1 μ H
 L3 — 9 turns #16 AWG 5/16" I.D.
 L4 — 4 turns #14 AWG 3/8" I.D.
 R1 = 2.4 Ω

Figure 7. 88 MHz Test Circuit

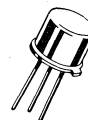
Advance Information

The RF Line

VHF Power Transistor

TP2306

2 W — 175 MHz
VHF POWER
TRANSISTOR



TO-39GE
CASE 79-04, STYLE 1

The TP2306 is designed for use in 12.5 V VHF applications and is ideally suited for use in the predriver or driver stage of a power amplifier where high gain is required.

- 175 MHz
- 2 W — P_{out}
- 12.5 V — V_{CC}
- High Gain — 12 dB Typ @ 175 MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	7.5 0.043	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	23.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	5	8	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 2\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	11.2	12.2	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 2\text{ W}$, $f = 175\text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 2\text{ W}$, $f = 175\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

This document contains information on a new product. Specifications and information herein are subject to change without notice.

The RF Line

VHF Power Transistor

The TP2307 is designed for 6 V to 12 V VHF applications and is intended for Class A, B or C medium power amplifiers, frequency multipliers or oscillator circuits.

Its grounded emitter construction gives excellent thermal dissipation and the ability of providing further heatsinking where necessary the case also acts as a good RF screen.

This device features high gain and an infinite VSWR rating at all phase angles at rated power output.

- 175 MHz
- 2.75 W — P_{out}
- 12.5 V — V_{CC}
- Rugged
- High Gain — 15.7 dB Typ @ 175 MHz

TP2307

2.75 W — 175 MHz
VHF POWER
TRANSISTOR



TO-39GE
CASE 79-04, STYLE 5

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	0.8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	8 0.05	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	40	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	12	15	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2.75 \text{ W}$, $f = 175 \text{ MHz}$)	G_{PE}	15.4	15.9	—	dB
Collector Efficiency ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2.75 \text{ W}$, $f = 175 \text{ MHz}$)	η_c	50	55	—	%
Load Mismatch ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2.75 \text{ W}$, $f = 175 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

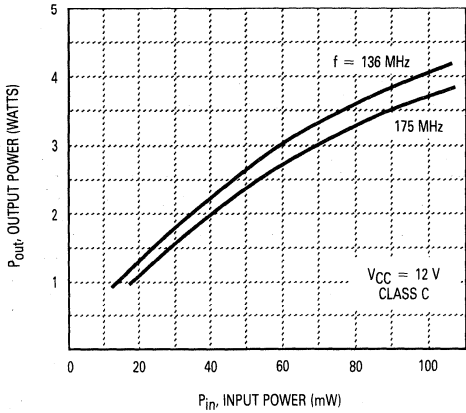


Figure 1. Output Power versus Input Power

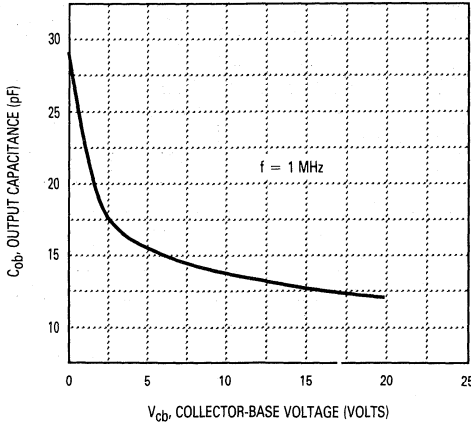
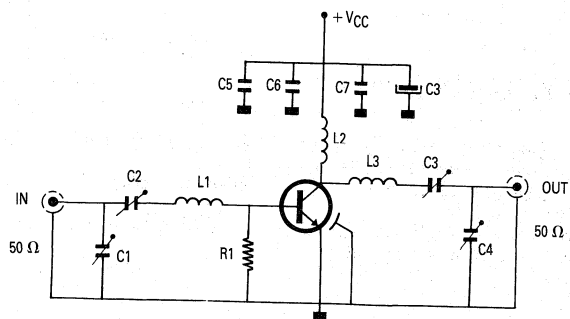


Figure 2. Output Capacitance



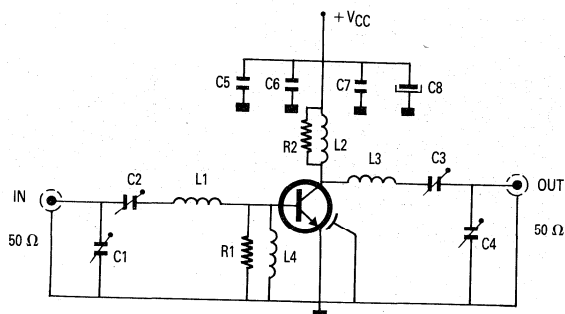
C1, C2, C3, C4 — ARCO 404 7–60 pF trimmer capacitor
 C5 — 1000 pF mica capacitor
 C6 — 10 nF ceramic disc
 C7 — 0.1 μ F ceramic disc
 C8 — 47 μ F electrolytic

L1, L3 — 2.5 turns, silvered wire ϕ 1.5 mm, 10 mm I.D.
 L2 — 3 turns, silvered wire ϕ 1.5 mm, 10 mm I.D.

R1 — 47 ohms, 1/2 W, carbon composition

NOTE: Case must be grounded.

Figure 3. 175 MHz Test Circuit



C1, C2, C3, C4 — ARCO 404 7–60 pF trimmer capacitor
 C5 — 1000 pF mica capacitor
 C6 — 10 nF ceramic disc
 C7 — 0.1 μ F ceramic disc
 C8 — 47 μ F electrolytic

L1, L3 — 2.5 turns, silvered wire ϕ 1.5 mm, 10 mm I.D.
 L2 — 3 turns, silvered wire ϕ 1.5 mm, 10 mm I.D.
 L4 — 0.45 μ H, molded coil

R1 — 47 ohms, 1/2 W

R2 — 220 ohms, 1/2 W

NOTE: Case must be grounded.

Figure 4. 88 MHz Test Circuit

The RF Line VHF Power Transistor

TP2314

**4 W — 175 MHz
VHF POWER TRANSISTOR
NPN SILICON**



**TO 39-GE
CASE 79-04, STYLE 5**

Designed for 6 V to 12 V VHF applications and is intended for Class A, B or C medium power amplifiers, frequency multipliers or oscillator circuits.

Grounded emitter construction gives excellent thermal dissipation and the ability of providing further heatsinking where necessary.

The case also acts as a good RF screen. Additional features are high gain and an infinite VSWR rating at all phase angles at rated power output.

- 175 MHz
- 4 W — P_{out}
- 12.5 V — V_{CC}
- Grounded Emitter Package for High Gain and Excellent Heat Dissipation
- Guaranteed Low Voltage Operation

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	8 0.05	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	40	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20\text{ V}$, $f = 1\text{ MHz}$)	C_{ob}	—	12	15	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 175\text{ MHz}$)	G_{PE1}	12	12.8	—	dB
Common-Emitter Amplifier Power Gain ($V_{CE} = 6\text{ V}$, $P_{out} = 1\text{ W}$, $f = 175\text{ MHz}$)	G_{PE2}	6	8.1	—	dB
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 88\text{ MHz}$)	G_{PE3}	12	12.8	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 175\text{ MHz}$)	η_c	55	64	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 175\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{in} = 250\text{ mW}$, $f = 88\text{ MHz}$) $f = 175\text{ MHz}$)	$Z_{in} = 4.5 - j4.8\text{ Ohms}$ $Z_{in} = 4.33 - j3.69\text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 88\text{ MHz}$) $f = 175\text{ MHz}$)	$Z_{Load} = 18.74 + j6.44\text{ Ohms}$ $Z_{Load} = 15.96 + j4.13\text{ Ohms}$				

TYPICAL CHARACTERISTICS

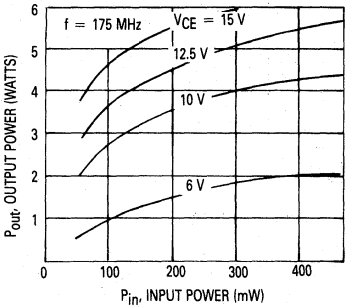


Figure 1. Output Power versus Input Power

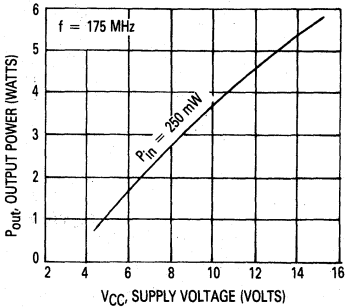


Figure 2. Output Power versus Supply Voltage

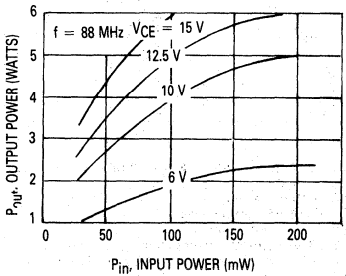


Figure 3. Output Power versus Input Power

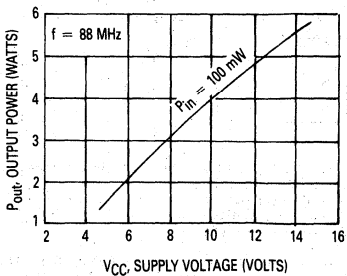


Figure 4. Output Power versus Supply Voltage

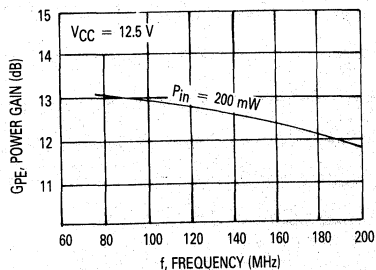


Figure 5. Power Gain versus Frequency

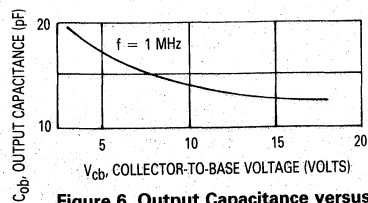


Figure 6. Output Capacitance versus Collector-To-Base Voltage

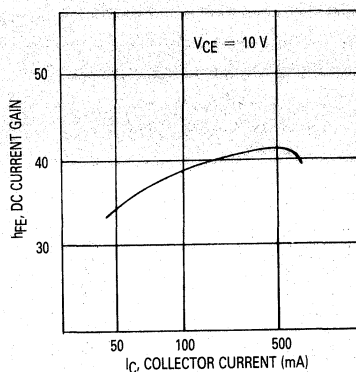
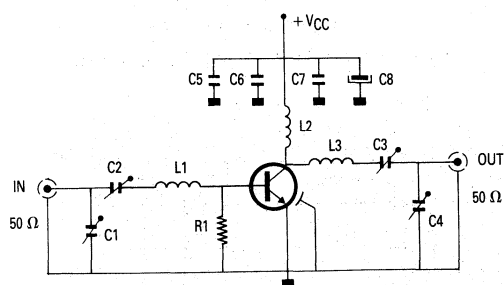


Figure 7. DC Current Gain versus Collector Current



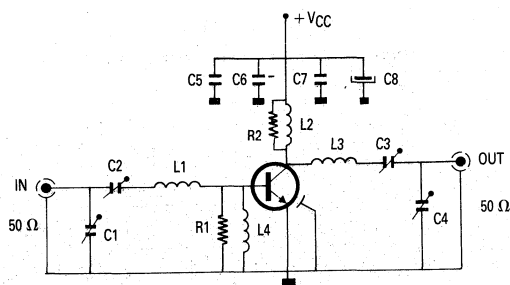
C1, C2, C3, C4 — ARCO 404 7-60 pF trimmer capacitor
 C5 — 1000 pF mica capacitor
 C6 — 10 nF ceramic disc
 C7 — 0.1 μ F ceramic disc
 C8 — 47 μ F electrolytic

L1, L3 — 2.5 turns, silvered wire ϕ 1.5 mm, 10 mm I.D.
 L2 — 3 turns, silvered wire ϕ 1.5 mm, 10 mm I.D.

R1 — 47 ohms, 1/2 W, carbon composition

NOTE: Case must be grounded.

Figure 8. 175 MHz Test Circuit



C1, C2, C3, C4 — ARCO 404 7-60 pF trimmer capacitor
 C5 — 1000 pF mica capacitor
 C6 — 10 nF ceramic disc
 C7 — 0.1 μ F ceramic disc
 C8 — 47 μ F electrolytic

L1, L3 — 2.5 turns, silvered wire ϕ 1.5 mm, 10 mm I.D.
 L2 — 3 turns, silvered wire ϕ 1.5 mm, 10 mm I.D.

L4 — 0.47 μ F, molded coil

R1 — 47 ohms, 1/2 W
 R2 — 220 ohms, 1/2 W

NOTE: Case must be grounded.

Figure 9. 88 MHz Test Circuit

TP2317

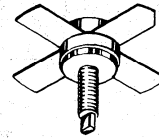
The RF Line
VHF Power Transistor

The TP2317 is designed for use in 12.5 V VHF amplifiers operating under Class A, B or C conditions.

Its construction, which incorporates gold metallization and diffused ballast resistors, enables the part to be used at its maximum ratings and be able to withstand an infinite VSWR at all phase angles.

- 175 MHz
- 20 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

20 W — 175 MHz
VHF POWER
TRANSISTOR



.380 SOE
CASE 145D-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $R_{BE} = 10 \Omega$)	$V_{(BR)CER}$	35	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ V, $I_E = 0$)	I_{CBO}	—	—	25	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	10	—	—	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5$ V, $P_{out} = 20$ W, $f = 175$ MHz)	G_{PE}	7	—	—	dB
Collector Efficiency ($V_{CE} = 12.5$ V, $P_{out} = 20$ W, $f = 175$ MHz)	η_C	55	—	—	%
Load Mismatch ($V_{CE} = 12.5$ V, $P_{out} = 20$ W, $f = 175$ MHz, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

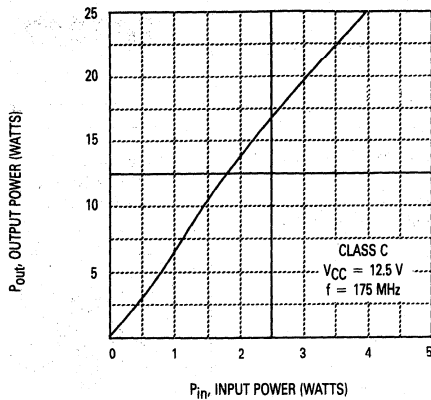


Figure 1. Power Transfer

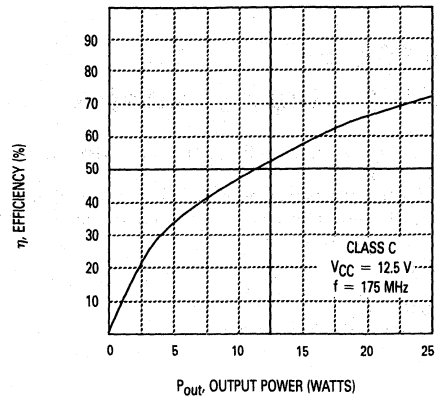


Figure 2. Collector Efficiency

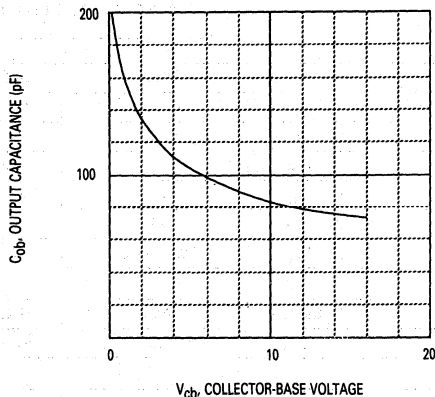


Figure 3. Output Capacitance (Typical)

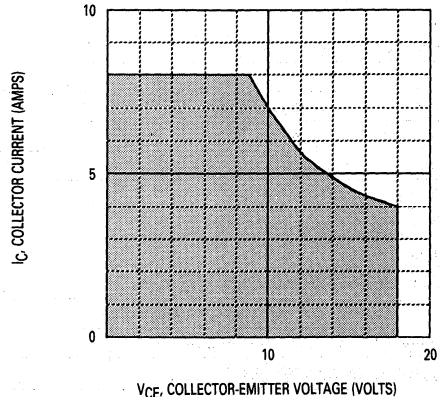


Figure 4. Safe Operating Area

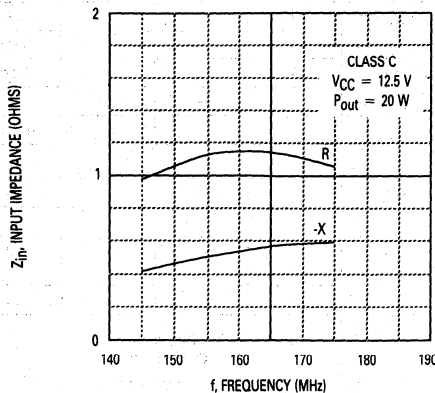


Figure 5. Input Series Impedance

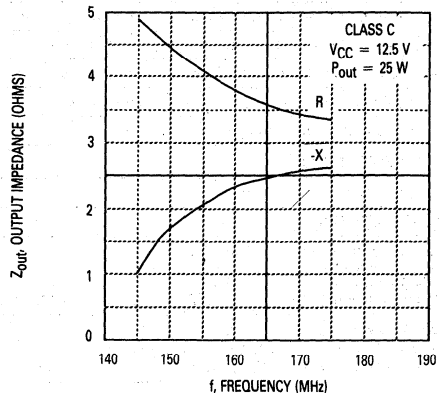
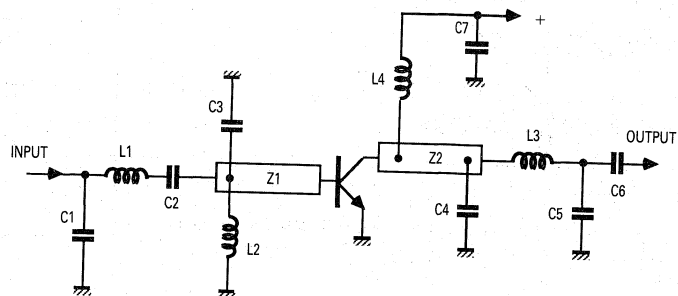


Figure 6. Output Series Impedance



- C1 — ARCO 4–40 pF Trimmer Capacitor
- C2 — ARCO 4–40 pF Trimmer Capacitor
- C3 — UNELCO 200 pF
- C4 — UNELCO 120 pF
- C5 — ARCO 7–120 pF Trimmer Capacitor
- C6 — ARCO 24–200 pF Trimmer Capacitor
- C7 — 1 nF + 0.1 μ F + 47 μ F
- L1 — 3 turns 16 AWG 0.16" I.D.
- L2 — 0.47 μ H Molded Coil
- L3 — 1 turn 16 AWG 0.16" I.D.
- L4 — 6 turns 12 AWG On 380 Ω 2 W Carbon
- Z1 — Base pad 0.06" single sided PC board 0.55" Lx0.28" W
- Z2 — Collector pad 0.06" single sided PC board 0.58" Lx0.28" W
- PC Board: Double Sided PC Board 0.06"

Figure 7. 175 MHz Test Circuit

Advance Information

The RF Line

VHF Power Transistor

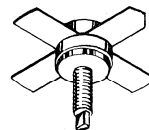
The TP2325 is designed for use in 12.5 V VHF amplifiers operating under Class A, B or C conditions.

Its construction which incorporates gold metallization and diffused ballast resistors enables the part to be used at its maximum ratings and be able to withstand an infinite VSWR at all phase angles.

- 175 MHz
- 25 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

TP2325

25 W — 175 MHz
VHF POWER
TRANSISTOR



.380 SOE
CASE 145D-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	5	mAdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	35	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	—	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 25\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	6.2	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 25\text{ W}$, $f = 175\text{ MHz}$)	η_c	60	—	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

The RF Line VHF Power Transistors

The TP2330 device is intended for use in VHF transmitter output stages where high gain is desired.

Use of gold metallization and diffused emitter ballast resistors result in enhanced reliability and ruggedness.

- 175 MHz
- 30 W — P_{out}
- 12.5 V — V_{CC}
- High Gain — 10 dB @ 175 MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	80 0.46	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	250	—
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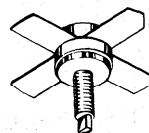
DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	70	100	pF
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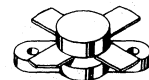
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TP2330 TP2330F

30 W — 175 MHz
VHF POWER
TRANSISTORS



.380 SOE
CASE 145D-01, STYLE 1
TP2330



.380 SOE F
CASE 211-07, STYLE 1
TP2330F

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 30\text{ W}$, $f = 175\text{ MHz}$)	TP2330 TP2330F GPE	10 9	— —	— —	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 30\text{ W}$, $f = 175\text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 30\text{ W}$, $f = 175\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 30\text{ W}$, $f = 175\text{ MHz}$)		$Z_{in} = 1.05 + j0.5\text{ Ohms}$			
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5\text{ V}$, $P_{out} = 30\text{ W}$, $f = 175\text{ MHz}$)		$Z_{Load} = 2.7 + j0.2\text{ Ohms}$			

TYPICAL CHARACTERISTICS

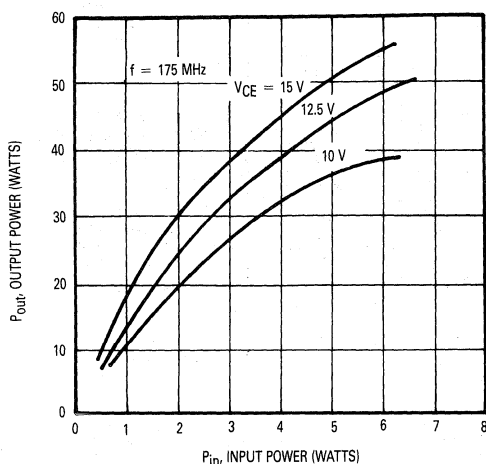


Figure 1. Output Power versus Frequency

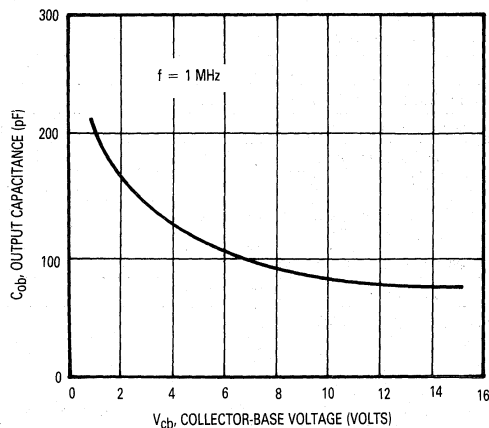


Figure 2. Output Capacitance versus Voltage

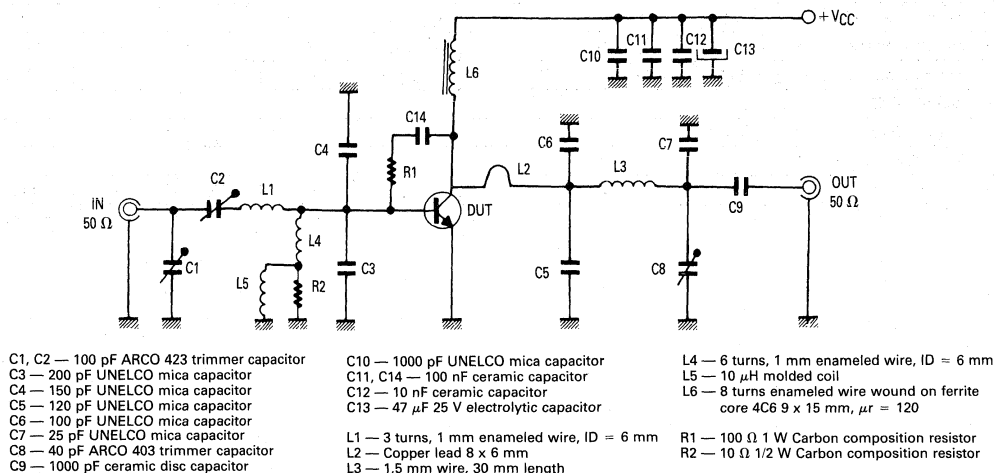


Figure 3. 175 MHz Test Circuit

The RF Line VHF Power Transistor

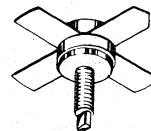
The TP2335 device is intended for use in VHF transmitter output stages where high gain is desired.

Use of gold metallization and diffused emitter ballast resistors result in enhanced reliability and ruggedness.

- 175 MHz
- 35 W — P_{out}
- 12.5 V — V_{CC}
- High Gain — 11 dB Min @ 175 MHz

TP2335

**35 W — 175 MHz
VHF POWER
TRANSISTOR**



**.380 SOE
CASE 145D-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	80 0.46	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 15\text{ V}$, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	70	100	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 35 \text{ W}$, $f = 175 \text{ MHz}$)	G_{PE}	11.1	—	—	dB
Collector Efficiency ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 35 \text{ W}$, $f = 175 \text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 35 \text{ W}$, $f = 175 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 35 \text{ W}$, $f = 175 \text{ MHz}$)		$Z_{in} = 1.05 + j0.5 \text{ Ohms}$			
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 35 \text{ W}$, $f = 175 \text{ MHz}$)		$Z_{Load} = 2.7 + j0.2 \text{ Ohms}$			

TYPICAL CHARACTERISTICS

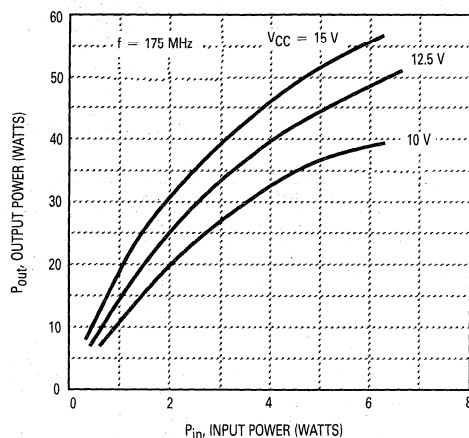


Figure 1. Output Power versus Input Power

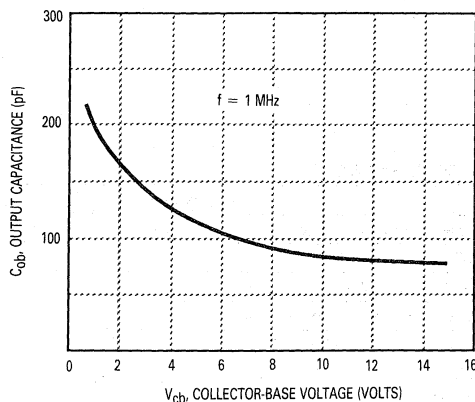


Figure 2. Collector-Base Capacitance versus Voltage

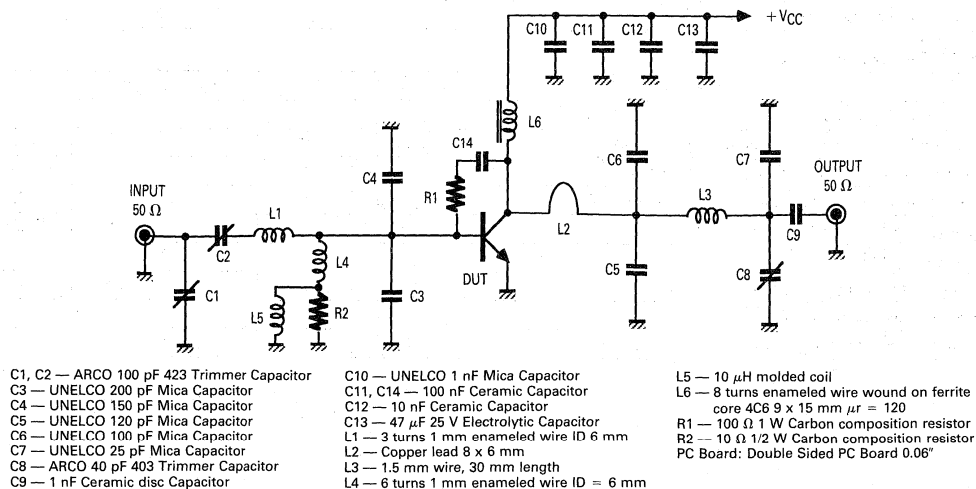


Figure 3. 175 MHz Test Circuit

The RF Line VHF Power Transistor

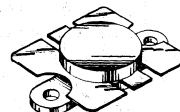
The TP2370 transistor is intended for land mobile applications operating over the 145–175 MHz frequency range with typical vehicular power supplies.

The combination of diffused silicon ballasting, gold metallization and low thermal resistance provide high reliability and improved ruggedness.

- 175 MHz
- 70 W — P_{out}
- 12.5 V — V_{CE}
- Gold Metallization for Reliability

TP2370

**70 W — 175 MHz
VHF POWER
TRANSISTOR**



**.500 J ZERO
CASE 316A-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 100$ mA, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ mA, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ V, $I_E = 0$)	I_{CBO}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	10	—	—	—
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5$ V, $P_{out} = 70$ W, $f = 175$ MHz)	G_{PE}	6.4	—	—	dB
Collector Efficiency ($V_{CE} = 12.5$ V, $P_{out} = 70$ W, $f = 175$ MHz)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 12.5$ V, $P_{out} = 70$ W, $f = 175$ MHz, Load VSWR = 10:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

2

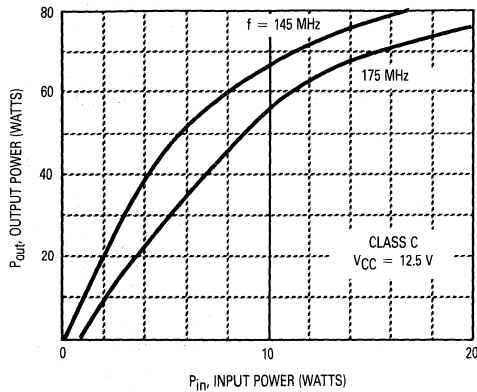


Figure 1. Output Power versus Input Power

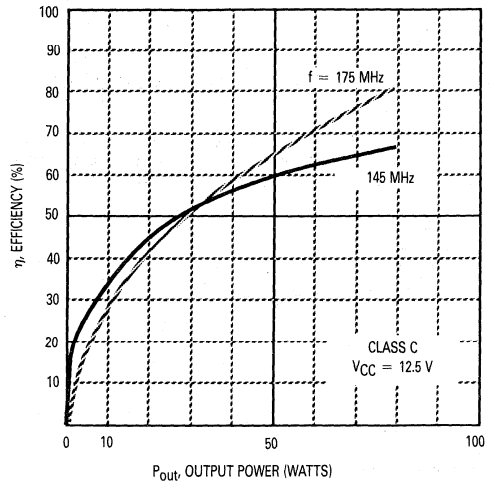


Figure 2. Collector Efficiency versus Output Power

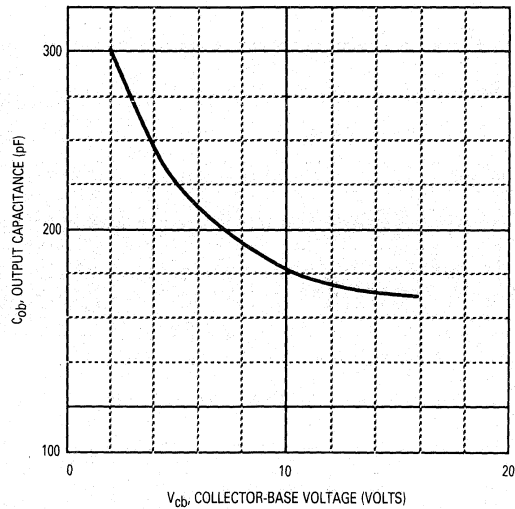


Figure 3. Output Capacitance versus Voltage

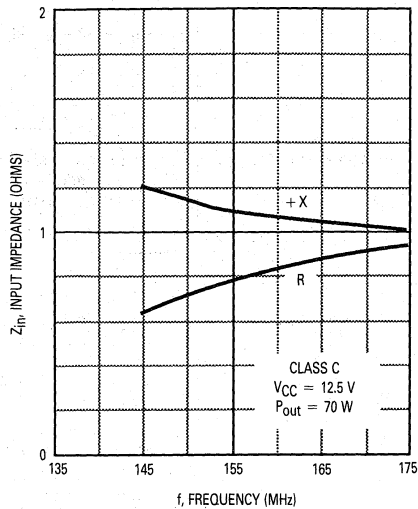


Figure 4. Input Series Impedance versus Frequency

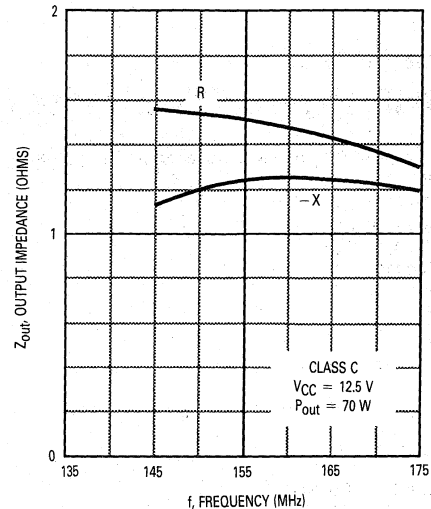


Figure 5. Output Series Impedance versus Frequency

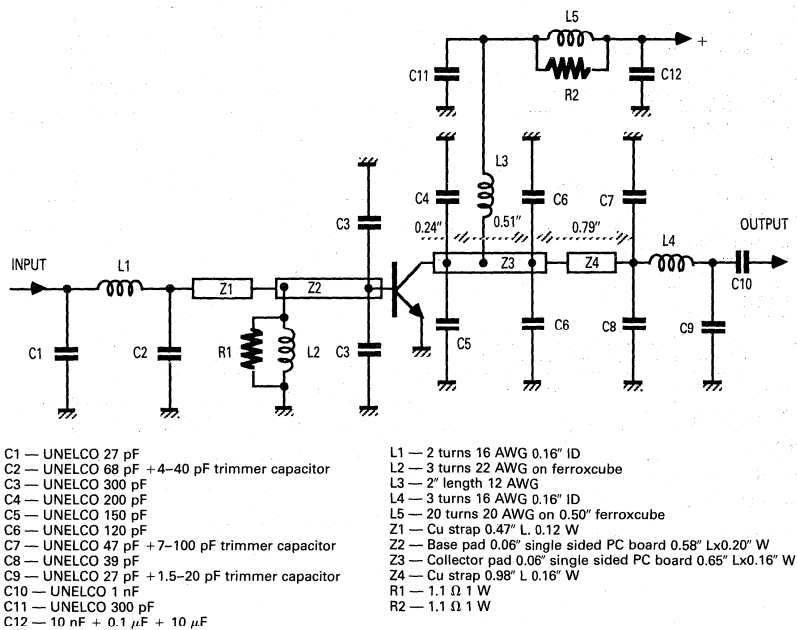


Figure 6. 175 MHz Test Circuit

The RF Line

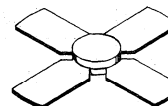
UHF Power Transistor

... designed for UHF large-signal amplifier applications in industrial and commercial FM equipment.

- 470 MHz
- 2 W — P_{out}
- 12.5 V — V_{CC}
- Rugged

TP2502

**2 W — 470 MHz
 UHF POWER
 TRANSISTOR**



**.280 SOE S
 CASE 249A-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	17	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.8	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	14.5 0.083	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 40\text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	17	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 40\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.45	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	15	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	7	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 470 \text{ MHz}$)	G_{PE}	10	—	—	dB
Collector Efficiency ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 470 \text{ MHz}$)	η_c	50	—	—	%
Load Mismatch ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 470 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

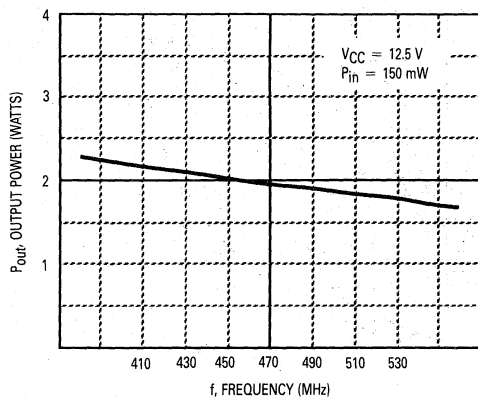


Figure 1. Output Power versus Frequency

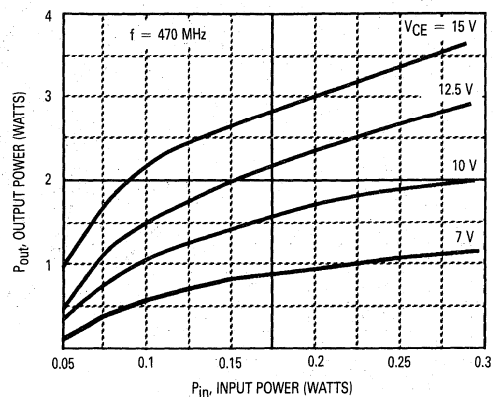


Figure 2. Output Power versus Input Power

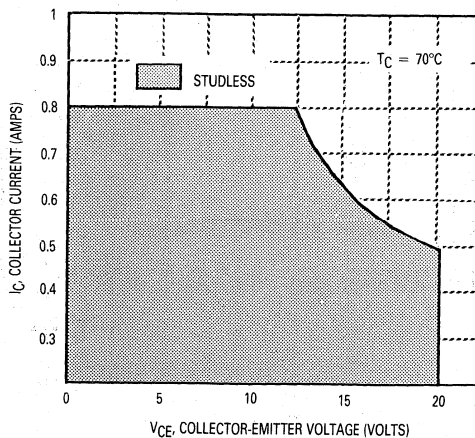


Figure 3. Safe Operating Area

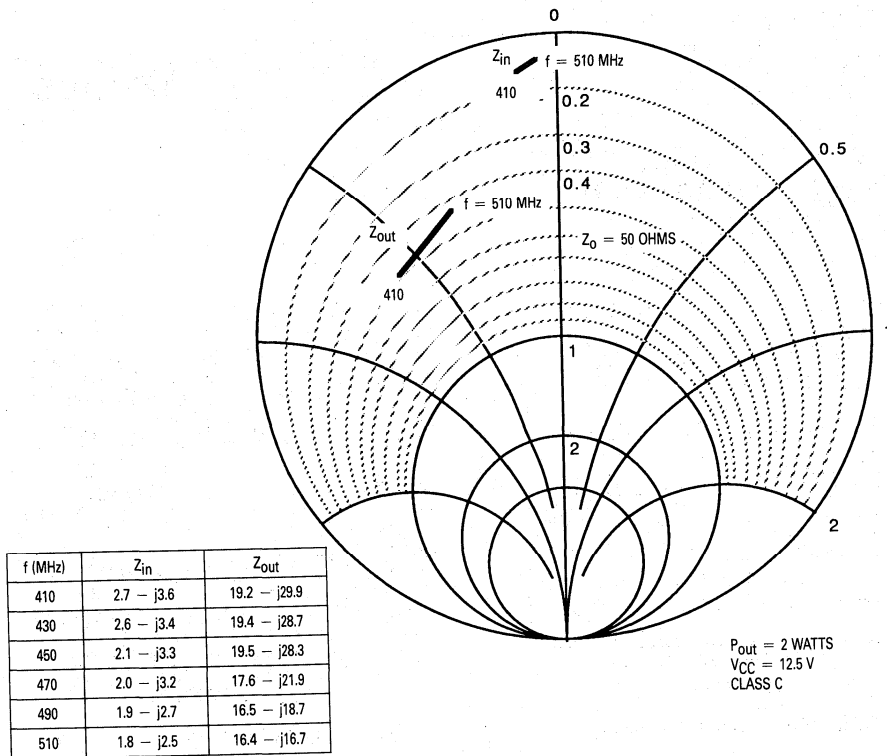
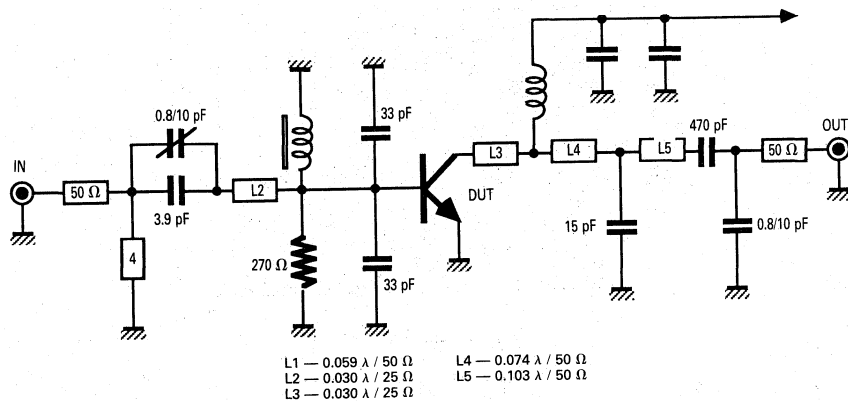


Figure 4. Series Equivalent Input/Output Impedances



All transmission lines references at 480 MHz

Figure 5. 470 MHz Test Circuit

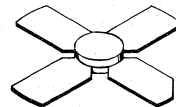
The RF Line
NPN Silicon
UHF Power Transistor

... designed for 12.5 V VHF and UHF amplifiers. High gain at reduced voltage and use of studless package make the TP2503 suitable for use in portable radio applications.

- 470 MHz
- 5 W — P_{out}
- 12.5 V — V_{CC}
- Capable of Withstanding Load Mismatch at Rated Output Power
- Guaranteed Performance at UHF, VHF and Midband

TP2503

5 W — 470 MHz
UHF POWER
TRANSISTOR



.280 SOE S
CASE 249A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1.7	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	17.5 0.1	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

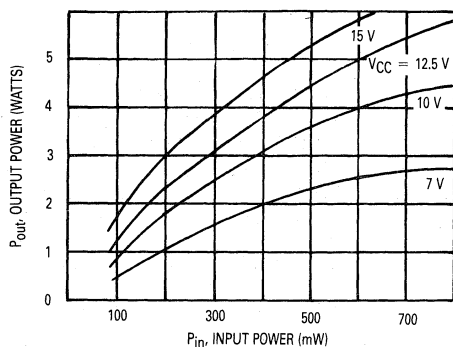
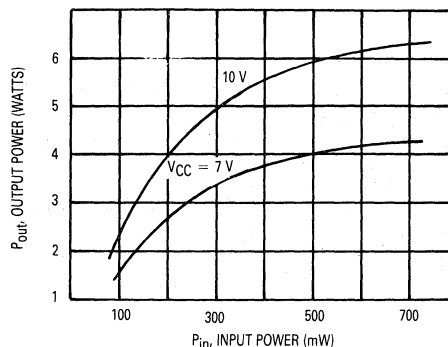
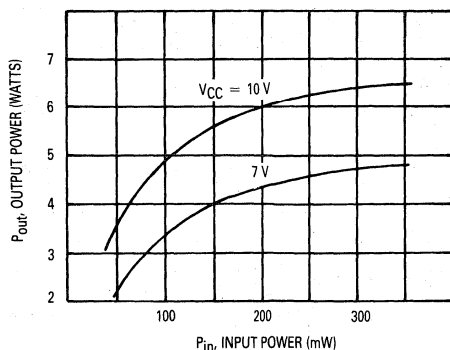
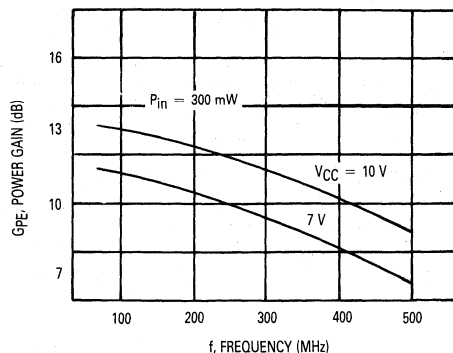
Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	13	17	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 470 \text{ MHz}$) ($V_{CE} = 9.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 175 \text{ MHz}$) ($V_{CE} = 9.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 88 \text{ MHz}$)	G_{PE1} G_{PE2} G_{PE3}	8.5 10.9 13.9	9 11.4 14.8	— — —	dB
Collector Efficiency ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 2 \text{ W}$, $f = 470 \text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 470 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{in} = 0.7 \text{ W}$, $f = 470 \text{ MHz}$)	$Z_{in} = 1.6 + j3.5 \text{ Ohms}$				
Load Impedance, Common Emitter (Typ) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 5 \text{ W}$, $f = 470 \text{ MHz}$)	$Z_{Load} = 9.55 + j5.75 \text{ Ohms}$				

TYPICAL CHARACTERISTICS

Figure 1. Output Power versus Input Power
 $f = 470 \text{ MHz}$ Figure 2. Output Power versus Input Power
 $f = 175 \text{ MHz}$ Figure 3. Output Power versus Input Power
 $f = 88 \text{ MHz}$ Figure 4. Power Gain versus Frequency
and Voltage Supply

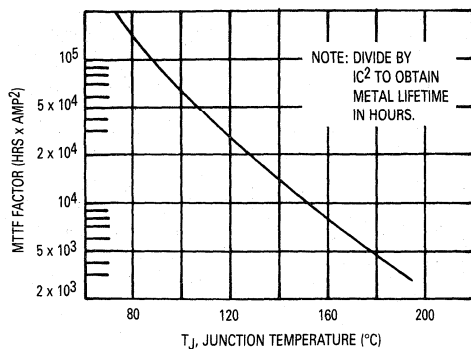


Figure 5. MTTF Factor versus Junction Temperature

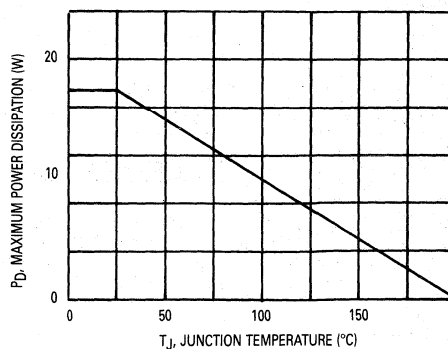
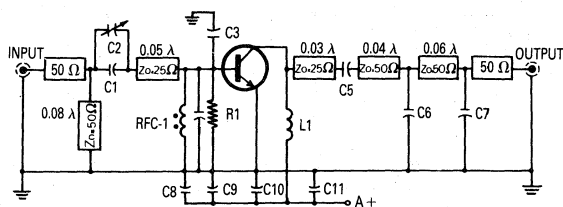


Figure 6. Power-Temperature Operating Curve



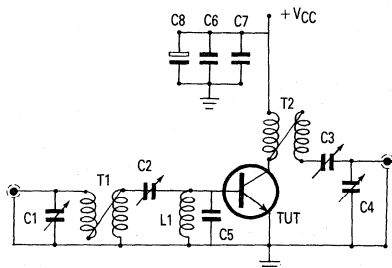
- C1 — 3.9 pF, ceramic chip
- C2 — 0.8–10 pF, Voltronics AP 10, variable
- C3, C4 — 25 pF, ceramic chip
- C5 — 1500 pF, ceramic chip
- C6 — 10 pF, Underwood
- C7 — 5 pF, Underwood
- C8 — 0.01 μ F, disc-ceramic
- C9 — 0.1 μ F, disc-ceramic
- C10 — 1000 pF, Underwood
- C11 — 5 μ F, electrolytic

L1 — 4 turns, #22 enameled, 0.1" I.D.

R1 — 750 Ω , 1/2 watt, carbon
RFC-1 — 2 1/2 turns #22 AWG on Ferroxcube VK211/17-4B

All transmission lines reference at 480 MHz

Figure 7. 450–510 MHz Test Circuit

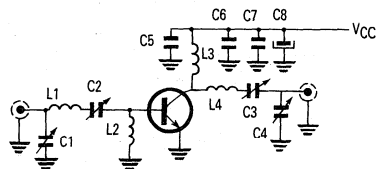


- C1, C2, C4 — 7–100 pF ARCO 423
- C3 — 24–200 pF ARCO 425
- C5 — 150 pF mica capacitor UNELCO
- C6 — 1000 pF mica capacitor UNELCO
- C7 — 10 nF ceramic disc
- C8 — 47 μ F/63 V electrolytic

L1 — 10 μ H Molded Coil

T1, T2 — Transmission Line Transformers 2 wires
8/10 mm twisted — 5 cm length

Figure 8. 175 MHz Test Circuit



- C1, C2, C3 — 24–200 pF ARCO 425
- C4 — 7–100 pF ARCO 423
- C5 — 1000 pF mica capacitor UNELCO
- C6 — 10 nF ceramic disc
- C7 — 0.1 μ F ceramic disc
- C8 — 100 μ F/35 V electrolytic

L1, L4 — 4 turns 14 AWG 1/2" I.D.

L2 — 0.47 μ H

L3 — 6 turns 14 AWG 1/2" I.D. Close Wound

Figure 9. 88 MHz Test Circuit

Advance Information

The RF Line

UHF Power Transistors

The TP2505/S are designed for 12.5 V UHF amplifiers. Their construction which incorporates emitter ballast resistors and gold metallization for long life, enables the parts to be used at their maximum ratings and withstand an infinite VSWR at all phase angles.

- 470 MHz
- 5 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1.7	Adc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	25 0.2	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	14	20	pF
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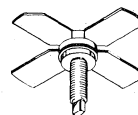
FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 5\text{ W}$, $f = 470\text{ MHz}$)	G_{PE}	8.5	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 5\text{ W}$, $f = 470\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 5\text{ W}$, $f = 470\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

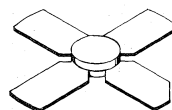
This document contains information on a new product. Specifications and information herein are subject to change without notice.

TP2505 TP2505S

5 W — 470 MHz
UHF POWER
TRANSISTORS



.280 SOE
CASE 244C-01, STYLE 1
TP2505



.280 SOE S
CASE 249A-01, STYLE 1
TP2505S

Advance Information

The RF Line

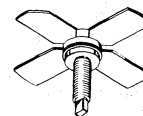
UHF Power Transistor

The TP2510 is designed for 12.5 V UHF amplifiers. Its construction which incorporates emitter ballast resistors and gold metallization for long life, enables the part to be used at its maximum ratings and withstand an infinite VSWR at all phase angles.

- 470 MHz
- 10 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

TP2510

10 W — 470 MHz
UHF POWER
TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	3.4	Adc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	35 0.286	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	3.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	4	mA dc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
---	----------	----	---	---	---

DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	30	pF
--	----------	---	---	----	----

FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 470\text{ MHz}$)	G_{PE}	6	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 470\text{ MHz}$)	η_C	55	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 470\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Advance Information

The RF Line

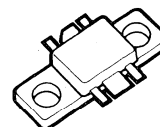
UHF Power Transistor

The TP2511 is designed for 12.5 V UHF amplifiers. Its construction which incorporates emitter ballast resistors and gold metallization for long life, enables the part to be used at its maximum ratings and withstand an infinite VSWR at all phase angles.

- 470 MHz
- 10 W — P_{out} @ $T_C = 70^\circ\text{C}$
- 12.5 V — V_{CC}
- High Gain — 10 dB Min, Class AB

TP2511

**10 W — 470 MHz
 UHF POWER
 TRANSISTOR**



EB
CASE 319C-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	35 0.286	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-50 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	3.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	4	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	40	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 16\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	28	—	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 100\text{ mA}$)	G_{PE}	10	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 10\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 100\text{ mA}$)	η_c	55	—	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

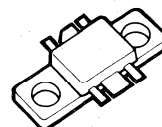
Advance Information
The RF Line
UHF Power Transistor

The TP2520 is designed for 12.5 V common-emitter amplifier applications in mobile cellular radio and other equipment operating in Class A, AB, B and C in the 400–470 MHz frequency band.

- 470 MHz
- 20 W — P_{out} @ $T_C = 70^\circ\text{C}$
- 12.5 V — V_{CC}
- High Gain — 10 dB Min, Class AB

TP2520

20 W — 470 MHz
UHF POWER
TRANSISTOR



EB
CASE 319C-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	40 0.286	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–50 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	3.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	8	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	40	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 16\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	56	—	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 20\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 100\text{ mA}$)	G_{pE}	10	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 20\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 100\text{ mA}$)	η_c	55	—	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

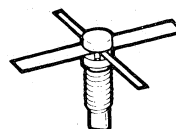
The RF Line **UHF Power Transistors**

The TP3009/S is designed for 12.5 V, 900 MHz common-emitter amplifier operating in the 820–960 MHz frequency region.

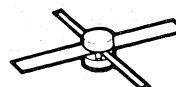
- 900 MHz
- 0.75 W — P_{out}
- 12.5 V — V_{CC}
- 7.5 dB Min Gain

TP3009 **TP3009S**

0.75 W — 900 MHz
UHF POWER
TRANSISTORS



.200 SOE
CASE 305B-01, STYLE 1
TP3009



.200 SOE S
CASE 305C-01, STYLE 1
TP3009S

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	0.75	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	26	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 90\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	25	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 12.5\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	2	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 0.75\text{ W}$, $f = 900\text{ MHz}$)	G_{PE}	7.5	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 0.75\text{ W}$, $f = 900\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 16\text{ V}$, $P_{out} = 0.75\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

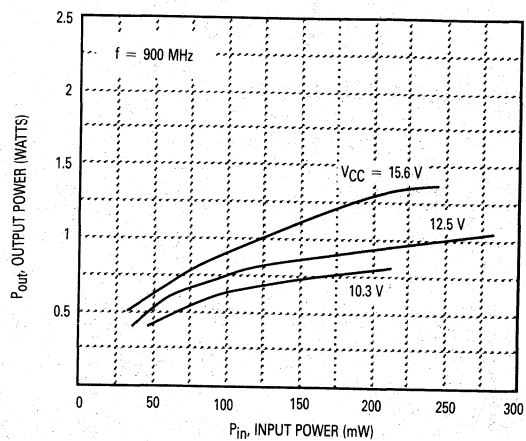


Figure 1. Output Power versus Input Power

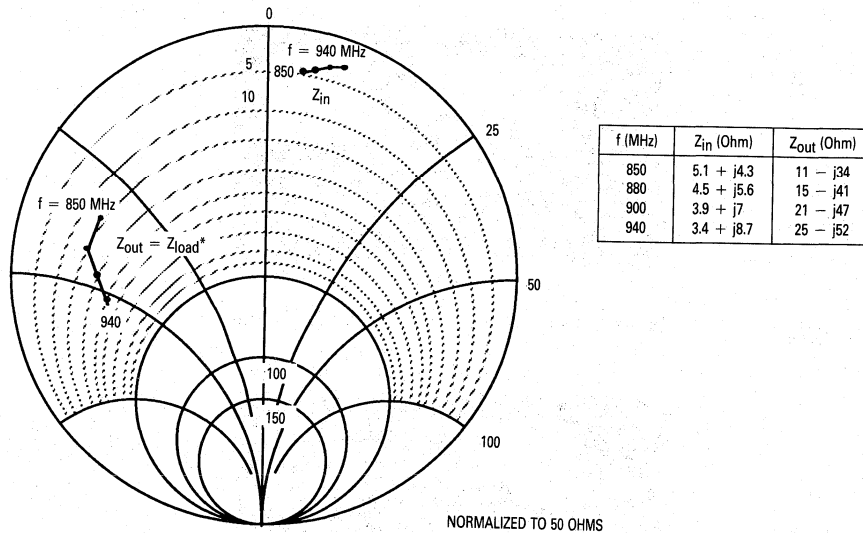
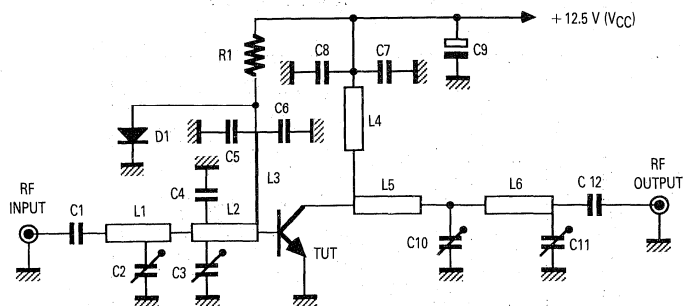


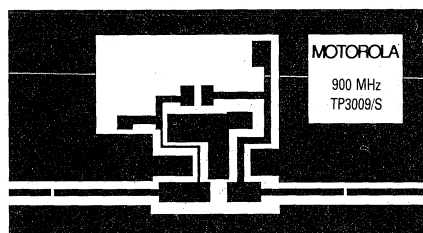
Figure 2. Series Equivalent Input/Output Impedances



C1 C5 C7 C12	CAPA CHIP 330 pF CGO SMT	L1	50Ω Line L=15mm
C2 C3 C10 C11	0.5-5 pF GKU Trimmer Capacitor	L2	25Ω Line L=7mm
C4	CAPA CHIP 3.9 pF	L3	75Ω Line L=27mm
C6 C8	15 nF Chip Capacitor 0805	L4	50Ω Line L=20mm
C9	ELECTROLITIC CAPACITOR 10MF 16V	L5	25Ω Line L=7mm
R1	RESISTOR // 2 X 270Ω 1/2 W	L6	50Ω Line L=28mm
D1	0.57 for Class B Operation		
Board Material	TEFLON GLASS 1/50 inch $\epsilon_r = 2.55$ Cu 35 μm		

Note: Amplifier tunable from 820 to 960 MHz.
Instantaneous Bandwidth — 40 MHz Typ.

Figure 3. Broadband Amplifier Circuit



Board Material: .020 In. Glass Teflon $\epsilon_r = 2.55$

Figure 4. Printed Circuit Board Layout (Not to Scale)

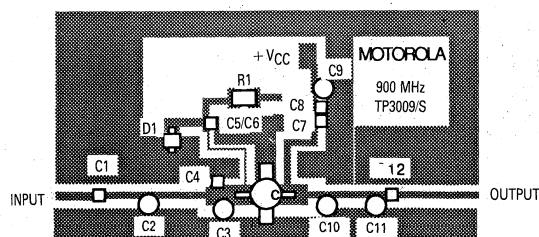


Figure 5. Component Layout

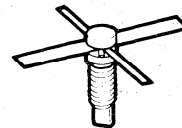
The RF Line UHF Power Transistors

The TP3010/S are designed for 12.5 V, 900 MHz common-emitter amplifiers operating in the 820–960 MHz frequency region.

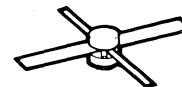
- 900 MHz
- 1.5 W — P_{out}
- 12.5 V — V_{CC}
- 7 dB Min Gain

TP3010 TP3010S

1.5 W to 900 MHz
UHF POWER
TRANSISTORS



.200 SOE
CASE 305B-01, STYLE 1
TP3010



.200 SOE S
CASE 305C-01, STYLE 1
TP3010S

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	14	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 25\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 4\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.4	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 320\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	25	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 12.5\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	8	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 900\text{ MHz}$)	G_{pE}	7	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 900\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 16\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

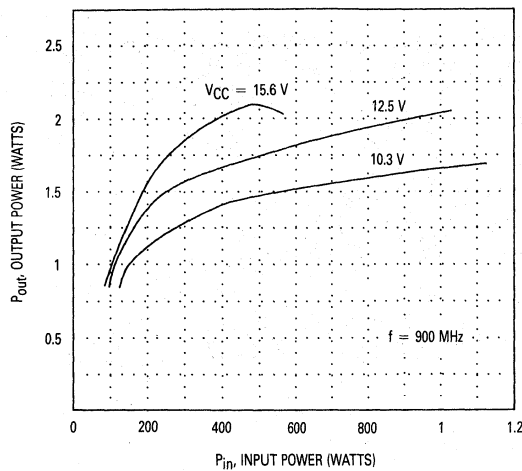
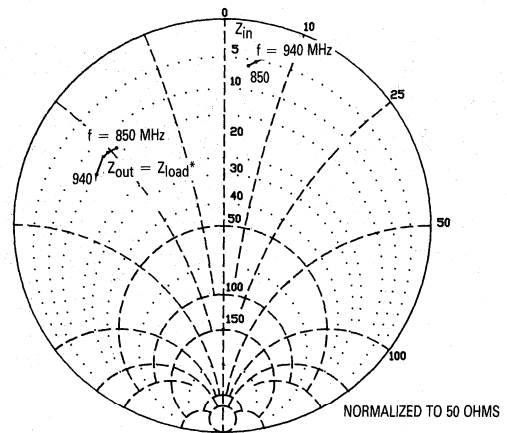
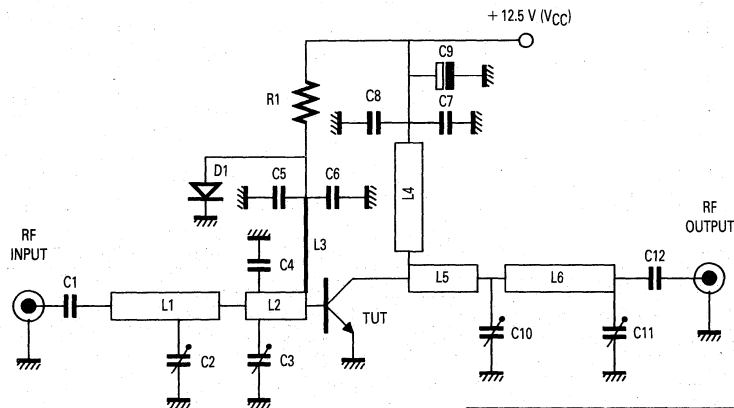


Figure 1. Output Power versus Input Power



f (MHz)	Z _{in} (Ohm)	Z _{out} (Ohm)
850	6.6 + j3.4	14 - j24
880	5.9 + j4.7	13.9 - j26
900	5.4 + j5.6	13.8 - j27
940	4.7 + j7.85	15.2 - j32

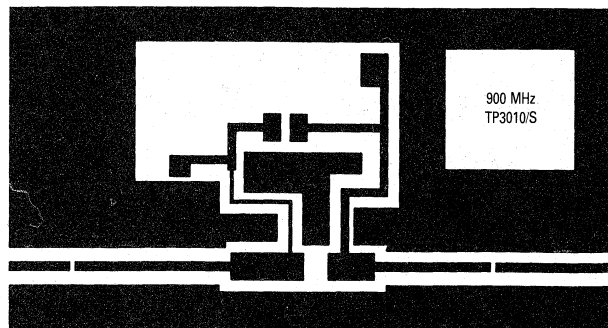
Figure 2. Series Equivalent Input/Output Impedances



Note: Amplifier tunable from 820 to 960 MHz.
Instantaneous Bandwidth — 40 MHz Typ.

C1, C5, C7, C12	Capacitor Chip 330 pF CGO SMT
C2, C3, C10, C11	0.5–5 pF GKU Trimmer Capacitor
C4	Capacitor Chip 3.9 pF
C6, C8	Capacitor Chip 15 nF
C9	Electrolytic Capacitor 10 MF 16 V
R1	Resistor // 2 x 270 Ohms 1/2 W
D1	0.57 for Class B Operation
L1	15 mm Z ₀ = 50 Ohm
L2, L5	7 mm Z ₀ = 25 Ohm
L3	27 mm Z ₀ = 75 Ohm
L4	20 mm Z ₀ = 50 Ohm
L6	28 mm Z ₀ = 50 Ohm
Board Material	.020 In. ε _r = 2.55, Teflon Glass

Figure 3. Broadband Amplifier Circuit



Board Material: .020 In. Glass Teflon $\epsilon_r = 2.55$

Figure 4. Printed Circuit Board Layout (Not to Scale)

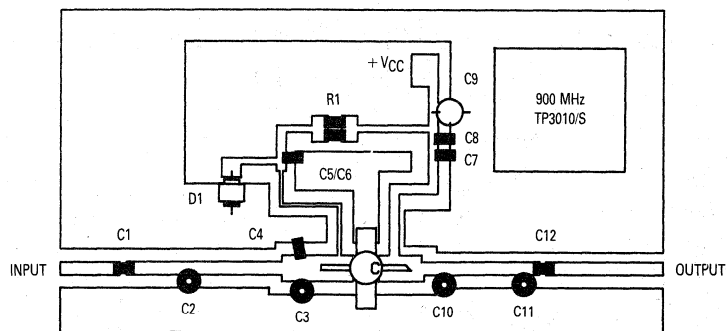


Figure 5. Component Layout

Advance Information

The RF Line

UHF Power Transistors

2

The TP3011/S is designed for 12.5 Volt, common-emitter amplifiers operating in the 820–960 MHz frequency range.

- 900 MHz
- 12.5 V — V_{CC}
- 4 W — P_{out} , Class B
- 7 dB Min Gain

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	1.5	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	8	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	25	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 16\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	15	—	pF
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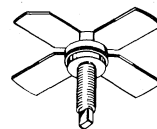
FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 900\text{ MHz}$)	G_{PE}	7	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 900\text{ MHz}$)	η_c	55	—	—	%
Load Mismatch ($V_{CE} = 16\text{ V}$, $P_{out} = 4\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

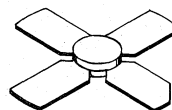
This document contains information on a new product. Specifications and information herein are subject to change without notice.

TP3011
TP3011S

4 W — 900 MHz
UHF POWER
TRANSISTORS



.280 SOE
CASE 244C-01, STYLE 1
TP3011



.280 SOE S
CASE 249A-01, STYLE 1
TP3011S

The RF Line

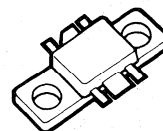
UHF Power Transistor

The TP3012 is designed for 12.5 V, 900 MHz common-emitter amplifier applications in mobile cellular radio and commercial FM equipments operating in the 820–960 MHz frequency band.

- 900 MHz
- 10/12 W — P_{out} , Class B (No Quiescent Current)
- 12.5 V — V_{CC}
- 7/6 dB Min Power Gain

TP3012

10/12 W — 900 MHz
UHF POWER
TRANSISTOR



EB
CASE 319C-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	3	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_E = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5$ mA, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ V, $I_E = 0$)	I_{CBO}	—	—	2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mA, $V_{CE} = 10$ V)	h_{FE}	40	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 16$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	28	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 10 \text{ W}$, $f = 900 \text{ MHz}$) ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 12 \text{ W}$, $f = 900 \text{ MHz}$)	G_{PE1} G_{PE2}	7 6	— —	— —	dB
Collector Efficiency ($V_{CE} = 12.5 \text{ V}$, $P_{out} = 10/12 \text{ W}$, $f = 900 \text{ MHz}$)	η_c	50	—	—	%
Load Mismatch ($V_{CE} = 16 \text{ V}$, $P_{out} = 10 \text{ W}$, $f = 900 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

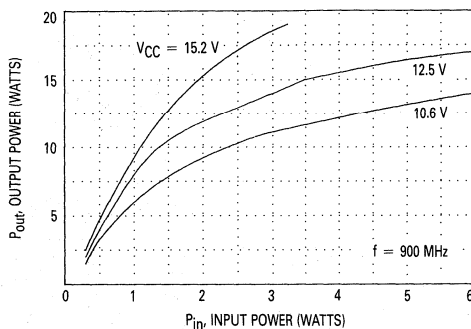
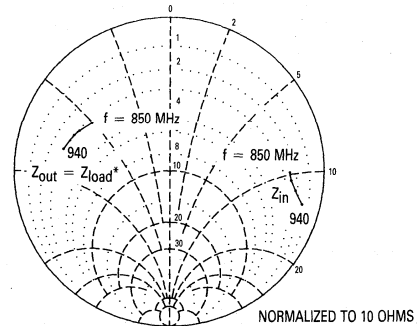
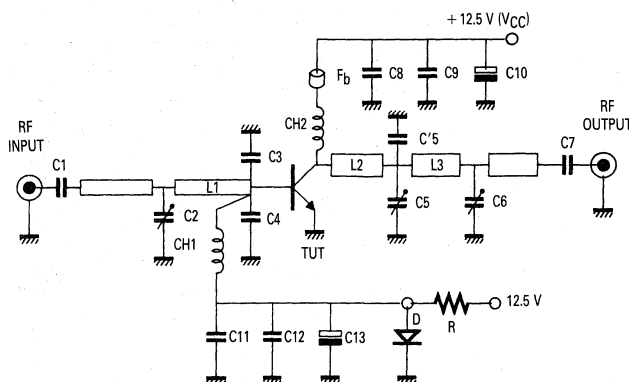


Figure 1. Output Power versus Input Power



f (MHz)	Z _{in} (Ohm)	Z _{out} (Ohm)
850	2.6 + j10	3.4 - j5.2
880	2.4 + j10.6	3.3 - j6.1
900	2.3 + j11.5	3.1 - j6.5
940	1.8 + j12.9	3 - j7.8

Figure 2. Series Equivalent Input/Output Impedances



C1, C7, C8, C11 — Capacitor Chip 330 pF CGO SMT
 C2, C5, C6 — 0.5–5 pF GPU Trimmer Capacitor
 C3, C4 — Capacitor Chip 12 pF CGO
 C'5 — Capacitor Chip 3.9 pF
 C10, C13 — Electrolytic Capacitor 10 MF 16 V
 CH1, CH2 — 3 Turns Dia. 5 mm Wire 8/10 mm
 Fb — Ferrite Bead
 D — Diode 0.58 V (for class B)
 R — Resistor 120 Ohm 1/2 W
 L1 — 25 mm $Z_0 = 50 \text{ Ohm}$
 L2 — 9 mm $Z_0 = 50 \text{ Ohm}$
 L3 — 8 mm $Z_0 = 50 \text{ Ohm}$
 Board Material: 0.020 in., $\epsilon_r = 2.55$, Teflon Glass

Figure 3. Broadband Amplifier Circuit

Advance Information

The RF Line

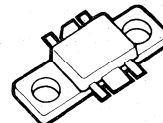
UHF Power Transistor

The TP3013 is designed for 12.5 Volt common-emitter amplifier applications in mobile cellular radio and commercial FM equipments operating in the 820-960 MHz frequency band.

- 900 MHz
- 4 W — P_{out} , Class B
- 12.5 V — V_{CC}
- 7.5 dB Min Gain

TP3013

4 W — 900 MHz
UHF POWER
TRANSISTOR



EB
CASE 319C-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1.5	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 15\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 5\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	40	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 16\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	15	—	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 900\text{ MHz}$)	G_{PE}	7.5	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 4\text{ W}$, $f = 900\text{ MHz}$)	η_c	50	—	—	%
Load Mismatch ($V_{CE} = 16\text{ V}$, $P_{out} = 4\text{ W}$, $f = 900\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Advance Information

The RF Line

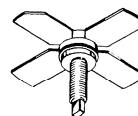
UHF Power Transistor

The TP3020A is designed for use in the 900 MHz mobile radio band. Its high gain and ability to operate Class A makes it an ideal choice as a driver operating Class A, Class B or Class C.

- 960 MHz
- 2.2 W — P_{out}
- 26 V — V_{CC}
- High Gain — 9 dB, Class A

TP3020A

**2.2 W — 960 MHz
 UHF POWER
 TRANSISTOR**



**.280 SOE
 CASE 244C-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	8.75 0.05	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	20	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Emitter-Base Breakdown Voltage ($I_E = 0.5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $R_{BE} = 75\ \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 24\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mA _{dc}

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	15	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	5	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 26\text{ V}$, $P_{out} = 2.2\text{ W}$, $f = 960\text{ MHz}$, $I_Q = 200\text{ mA}$)	G_{PE}	9.1	—	—	dB
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Advance Information

The RF Line

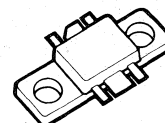
UHF Power Transistor

... designed for common-emitter operation in the 900 MHz mobile radio band. Use of gold metallization and silicon diffused ballast resistors results in a medium power output/driver transistor with state-of-the-art ruggedness and reliability.

- 960 MHz
- 15 W — P_{out}
- 26 V — V_{CC}
- High Gain — 8.5 dB, Class AB

TP3022A

**15 W — 960 MHz
 UHF POWER
 TRANSISTOR**



EB
CASE 319C-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	6	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $R_{BE} = 75\ \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 24\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	15	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 24\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	17	25	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 26\text{ V}$, $P_{out} = 15\text{ W}$, $f = 960\text{ MHz}$, $I_Q = 50\text{ mA}$)	G_{PE}	8.5	—	—	dB
Collector Efficiency ($V_{CE} = 26\text{ V}$, $P_{out} = 15\text{ W}$, $f = 960\text{ MHz}$, $I_Q = 50\text{ mA}$)	η_c	45	—	—	%

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TP3023

Advance Information

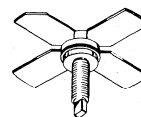
The RF Line

UHF Power Transistor

4 W — 960 MHz
UHF POWER
TRANSISTOR

... designed for common-emitter operation in the 900 MHz mobile radio band. Use of gold metallization and silicon diffused ballast resistors results in a medium power output/driver transistor with state-of-the-art ruggedness and reliability.

- 960 MHz
- 4 W — P_{out} @ $T_C = 70^\circ\text{C}$
- 24 V — V_{CC}
- 8.5 dB Gain, Class AB



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	18 0.143	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	7	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Base Breakdown Voltage ($I_C = 2\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $R_{BE} = 75\ \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 24\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	1	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	15	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	7	10	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 24\text{ V}$, $P_{out} = 4\text{ W}$, $f = 960\text{ MHz}$, $T_C = 70^\circ\text{C}$, $I_Q = 50\text{ mA}$)	G_{PE}	8.5	—	—	dB
Collector Efficiency ($V_{CE} = 24\text{ V}$, $P_{out} = 4\text{ W}$, $f = 960\text{ MHz}$, $T_C = 70^\circ\text{C}$, $I_Q = 50\text{ mA}$)	η_c	55	—	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Advance Information

The RF Line

UHF Linear Power Transistor

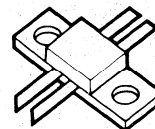
The TP3024A is a balanced transistor designed specifically for use in cellular radio systems.

This device permits the design of a Class AB push-pull, high gain, broadband amplifier having a high degree of linearity without the need for complicated biasing circuitry.

- 960 MHz
- 35.5 W — P_{out}
- 26 V — V_{CC}
- 7.5 dB Gain
- Push-Pull Configuration

TP3024A

35.5 W — 960 MHz
UHF LINEAR POWER
TRANSISTOR



BMA2
CASE 395-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 75^\circ\text{C}$)	$R_{\theta JC}$	3	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (Note 1)

Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $R_{BE} = 75\ \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 24\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	10	mAdc

ON CHARACTERISTICS (Note 1)

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	15	—	100	—
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DYNAMIC CHARACTERISTICS (Note 1)

Output Capacitance ($V_{CB} = 24\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	17	25	pF
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FUNCTIONAL TESTS (Note 2)

Common-Emitter Amplifier Power Gain ($V_{CE} = 26\text{ V}$, $P_{out} = 35.5\text{ W}$, $f = 960\text{ MHz}$, $I_{Q_{total}} = 150\text{ mA}$)	G_{PE}	7.5	—	—	dB
Collector Efficiency ($V_{CE} = 26\text{ V}$, $P_{out} = 35.5\text{ W}$, $f = 960\text{ MHz}$, $I_{Q_{total}} = 150\text{ mA}$)	η_c	45	—	—	%

Notes: 1. Each transistor chip measured separately.

2. Both transistor chips operating in push-pull amplifier.

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Advance Information

The RF Line

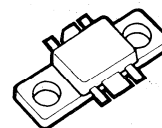
UHF Power Transistor

The TP3026 is specifically designed for operation as the final stage in 960 MHz mobile base station amplifiers. Utilization of emitter ballast resistors and gold metallization results in a transistor having a high degree of reliability and ruggedness.

- 960 MHz
- 25 W — P_{out} @ $T_C = 70^\circ\text{C}$
- 24 V — V_{CC}
- 8 dB Gain, Class AB

TP3026

**25 W — 960 MHz
UHF POWER
TRANSISTOR**



EB
CASE 319C-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	52 0.4	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-50 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	2.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage ($I_C = 30\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	48	50	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $R_{BE} = 75\ \Omega$)	$V_{(BR)CER}$	40	50	—	Vdc
Collector Cutoff Current ($V_{CB} = 24\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 26\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	34	50	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 24\text{ V}$, $P_{out} = 25\text{ W}$, $f = 960\text{ MHz}$, $T_C = 70^\circ\text{C}$, $I_Q = 100\text{ mA}$)	G_{PE}	8	—	—	dB
Collector Efficiency ($V_{CE} = 24\text{ V}$, $P_{out} = 25\text{ W}$, $f = 960\text{ MHz}$, $T_C = 70^\circ\text{C}$, $I_Q = 100\text{ mA}$)	η_c	50	—	—	%

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TP3040

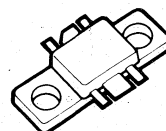
The RF Line

UHF Power Transistor

The TP3040 is specifically designed for operation as the final stage in 960 MHz mobile base station amplifiers. Utilization of emitter ballast resistors and gold metallization results in a transistor having a high degree of reliability and ruggedness.

- 960 MHz
- 40 W — P_{out} @ $T_C = 70^\circ\text{C}$
- 26 V — V_{CC}
- 8 dB Gain, Class AB

40 W — 960 MHz
UHF POWER
TRANSISTOR



EB
CASE 319C-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	70 0.56	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-50 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	1.8	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	28	30	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 40\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	50	55	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 24\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 26\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	42	62	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 26\text{ V}$, $P_{out} = 40\text{ W}$, $f = 960\text{ MHz}$, $T_C = 70^\circ\text{C}$, $I_Q = 150\text{ mA}$)	G_{PE}	8	—	—	dB
Collector Efficiency ($V_{CE} = 26\text{ V}$, $P_{out} = 40\text{ W}$, $f = 960\text{ MHz}$, $T_C = 70^\circ\text{C}$, $I_Q = 150\text{ mA}$)	η_c	55	—	—	%

TYPICAL CHARACTERISTICS

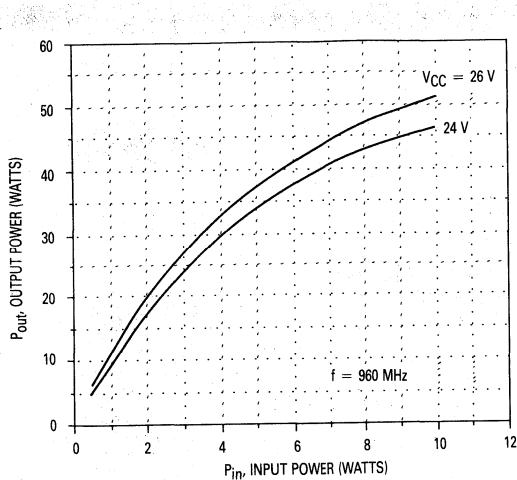
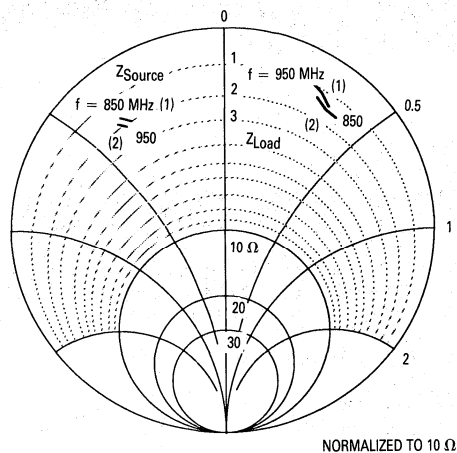
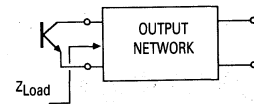


Figure 1. Output Power versus Input Power

(2) $P_{out} = 30 \text{ W}$, $V_{CE} = 26 \text{ V}$

f (MHz)	Z_{Source}	Z_{Load}
850	$1.7 - j3.7$	$1.2 + j3.6$
900	$1.8 - j3.6$	$1.1 + j3.16$
950	$2 - j3.5$	$1 + j2.76$

(1) $P_{out} = 40 \text{ W}$, $V_{CE} = 26 \text{ V}$

f (MHz)	Z_{Source}	Z_{Load}
850	$1.7 - j3.8$	$1.5 + j4.0$
900	$1.75 - j3.7$	$1.3 + j3.4$
950	$1.9 - j3.6$	$1.2 + j3.2$

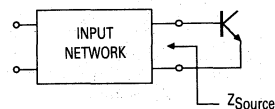


Figure 2. Series Equivalent Input/Output Impedances

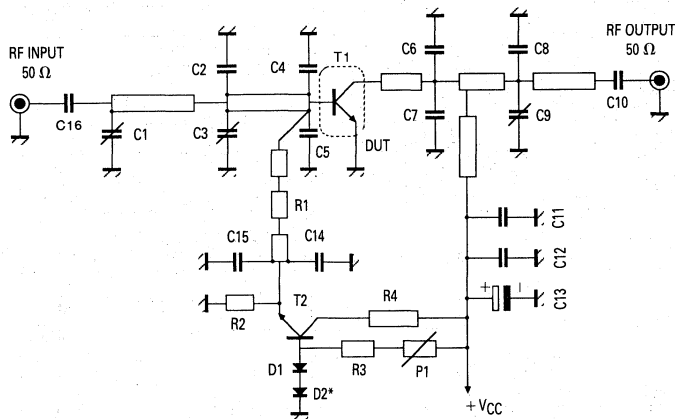


Figure 3. 960 MHz Test Circuit

*CONTACT WITH RF TRANSISTOR

C1, C10, C11, C14 — Capacitor Chip 330 pF 5%
 C2 — Capacitor Chip 4.7 pF 5%
 C3 — Capacitor Adjust. 1–4 pF
 C4, C5 — Capacitor Chip 18 pF
 C6, C7 — Capacitor Chip 10 pF
 C8 — Capacitor Chip 4.7 pF
 C9 — Capacitor Adjust. 1–4 pF
 C13 — Capacitor 10 μF 35 V
 C15, C12 — 15 nF
 D1, D2 — 1N4148
 R1 — 2.2 Ohms
 R2 — 47 Ohms
 R3 — 1.2 k Ohms
 R4 — 100 Ohms 3 W
 P1 — 10 k Ohms
 T2 — BD135 on heatsink
 Board Material: .020 In., $\epsilon_r = 2.55$, Teflon Glass

The RF Line

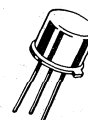
UHF Linear Power Transistor

... uses gold metallization and diffused emitter ballast resistors for long term reliability. Its main characteristics are high output level, low noise figure and high f_T . These features make the TP3093 an ideal candidate for broadband linear amplifiers up to 1 GHz (MATV), oscillators, mixers, multipliers and other applications.

- 3 GHz f_T
- 1 Volt Output DIN 45004 B
- 3.5 dB Gain @ 500 MHz
- Gold Metallization for Reliability
- Diffused Emitter Ballast Resistors for Ruggedness

TP3093

**UHF LINEAR
POWER
TRANSISTOR**



**TO-39
CASE 79-04, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	200	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	3.5 0.02	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	4	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Maximum Unilateral Gain ($V_{CE} = 15\text{ V}$, $I_C = 50\text{ mA}$, $f = 500\text{ MHz}$)	G_{UMAX}	—	9.5	—	dB
Cutoff Frequency ($V_{CE} = 15\text{ V}$, $I_C = 50\text{ mA}$, $f = 500\text{ MHz}$)	f_T	—	3	—	GHz
Insertion Gain ($V_{CE} = 15\text{ V}$, $I_C = 50\text{ mA}$, $f = 500\text{ MHz}$)	$|S_{21}|^2$	—	8.5	—	dB
Intermodulation Distortion — 3 Tone (DIN 45004/B, $f = 500\text{ MHz}$, $V_{CE} = 15\text{ V}$, $I_C = 60\text{ mA}$, $R_{Load} = 75\text{ Ohms}$)					
$V_{out} = 700\text{ mV}$	IMD ₁	—	-65	—	dB
$V_{out} = 1000\text{ mV}$	IMD ₂	—	-56	—	dB

TYPICAL CHARACTERISTICS

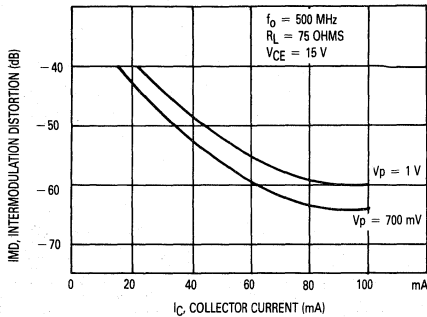


Figure 1. DIN 45004 B IMD versus I_C Collector Current

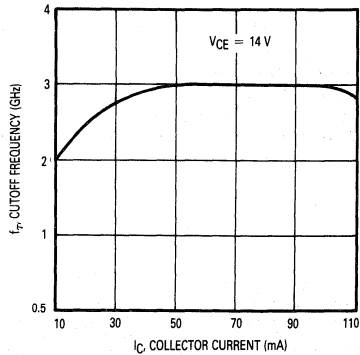


Figure 2. Cutoff Frequency versus Current

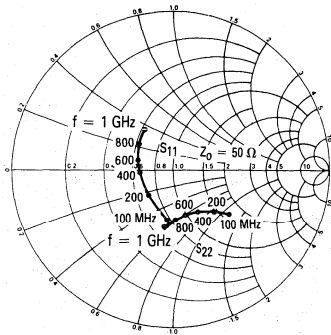


Figure 3. $S_{22} - S_{11}$ Parameters versus Frequency
 $V_{CE} = 15\text{ V}$
 $I_C = 50\text{ mA}$

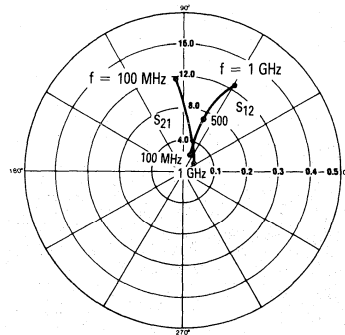


Figure 4. $S_{21} - S_{12}$ Parameters versus Frequency
 $V_{CE} = 15\text{ V}$
 $I_C = 50\text{ mA}$

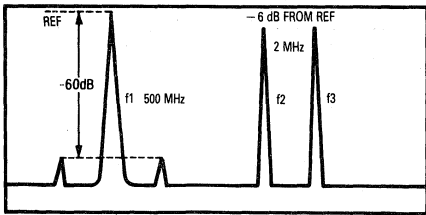


Figure 5. Intermodulation Distortion Test

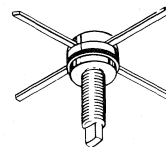
The RF Line UHF Linear Power Transistor

... designed for UHF broadband linear amplification such as in high level 1 Volt MATV Amplifiers up to 860 MHz or low power 200 mW TV Transposer stages. The TP3098 features gold metallization, diffused emitter ballast resistors and a high cutoff frequency.

- High Output
- 1 V (DIN 45004/B)
- 200 mW (DIN 45004/K)
- 10 dB Gain @ 860 MHz
- Gold Metallization for Reliability
- Diffused Emitter Ballast Resistors

TP3098

**UHF LINEAR
POWER
TRANSISTOR**



**TO-117A
CASE 244D-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	0.2	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	5 0.03	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.2	mAdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	25	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 90\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	60	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	2.5	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure ($V_{CE} = 15\text{ V}$, $I_C = 40\text{ mA}$, $f = 500\text{ MHz}$)	NF	—	—	6.5	dB
Cutoff Frequency ($V_{CE} = 15\text{ V}$, $I_C = 100\text{ mA}$, $f = 500\text{ MHz}$)	f_T	—	2.6	—	GHz
Maximum Unilateral Gain ($V_{CE} = 15\text{ V}$, $I_C = 100\text{ mA}$, $f = 500\text{ MHz}$)	G_{UMAX}	—	13.5	—	dB
Insertion Gain ($V_{CE} = 15\text{ V}$, $I_C = 100\text{ mA}$, $f = 500\text{ MHz}$)	$|S_{21}|^2$	—	11.5	—	dB
Intermodulation Distortion 3 Tone — DIN 45004/B ($f = 500\text{ MHz}$, $R_{Load} = 75\text{ Ohms}$, $V_{CE} = 15\text{ V}$, $I_C = 100\text{ mA}$, $V_{out} = 700\text{ mV}$)	IMD	—	-65	-60	dB

TYPICAL CHARACTERISTICS

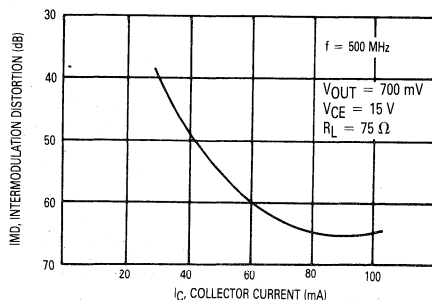


Figure 1. IMD (DIN 45004 B) versus Collector Current

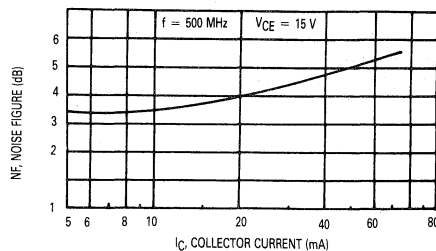
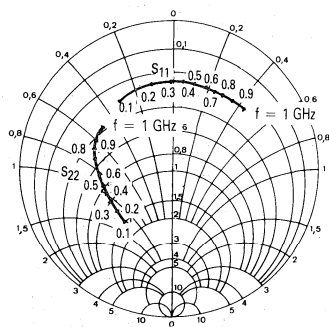
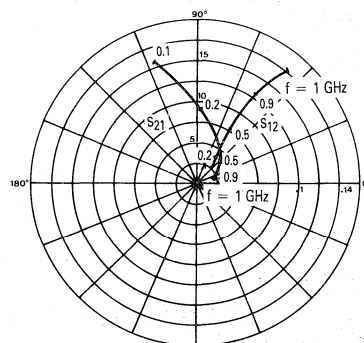
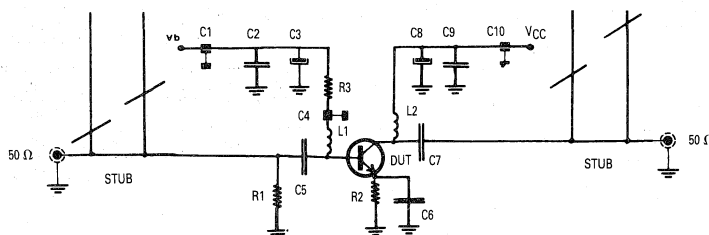


Figure 2. Noise Figure versus Collector Current

Figure 3. S_{11} — S_{22} Parameters versus Frequency
 $V_{CE} = 15\text{ V}$
 $I_C = 100\text{ mA}$ Figure 4. S_{21} — S_{12} Parameters versus Frequency
 $V_{CE} = 15\text{ V}$
 $I_C = 100\text{ mA}$ 

L1, L2 — 0.1 nH molded coil

C1, C4, C10 — 1000 pF by pass

C2, C9 — 470 pF ceramic disc

C5, C7 — 220 pF ceramic chip

C3, C8 — 47 μF 40 V electrolytic

C6 — 2 x 220 pF chip one at each emitter lead

R1 — 100 ohms 1/4 W carbon resistor

R2 — 39 ohms 1/4 W carbon resistor

R3 — 1.5 k ohms 1/4 W carbon resistor

Figure 5. 500 MHz Test Fixture

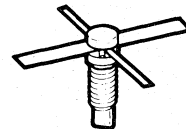
The RF Line UHF Linear Power Transistor

The TP3400 is a NPN transistor gold metallized for reliability.
The transition frequency of 3 GHz make this transistor a high gain — high output power part ideal for MATV — CATV linear amplification over the band 40–900 MHz.

- 3 GHz f_T
- 1.2 Volt DIN 45004 B
- 13.5 dB Gain @ 860 MHz
- Gold Metallization for Reliability

TP3400

**UHF LINEAR
POWER
TRANSISTOR**



**.200 SOE
CASE 305B-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	30	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1 \text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.25 \text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10 \text{ mA}$, $R_{BE} = 10 \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28 \text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.25	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100 \text{ mA}$, $V_{CE} = 5 \text{ V}$)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20 \text{ V}$, $I_E = 0$, $f = 1 \text{ MHz}$)	C_{ob}	—	—	3	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure ($V_{CE} = 10\text{ V}$, $I_C = 125\text{ mA}$, $f = 500\text{ MHz}$)	NF	—	7	—	dB
Cutoff Frequency ($V_{CE} = 18\text{ V}$, $I_C = 125\text{ mA}$)	f_T	2.5	—	—	GHz
Intermodulation Distortion 3 Tone — DIN 45004/B ($f = 860\text{ MHz}$, $R_{Load} = 75\text{ Ohms}$, $V_{CE} = 18\text{ V}$, $I_C = 125\text{ mA}$, $V_{out} = 1.2\text{ V}$)	IMD	—	-60	—	dB
Power Gain ($f = 860\text{ MHz}$, $I_C = 125\text{ mA}$, $V_{CE} = 18\text{ V}$, $V_{out} = 1.2\text{ V}$)	Gp	13.5	—	—	dB

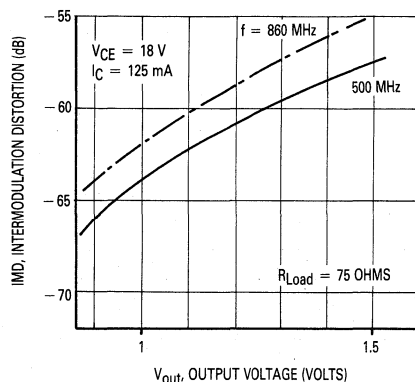


Figure 1. IMD (DIN 45004 B) versus Output Voltage

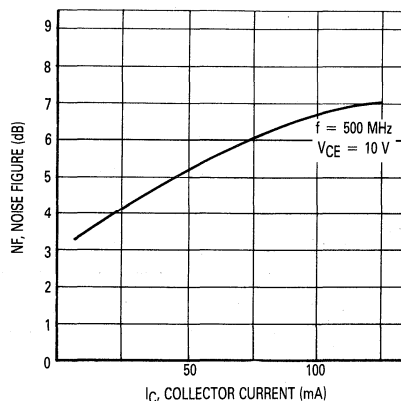
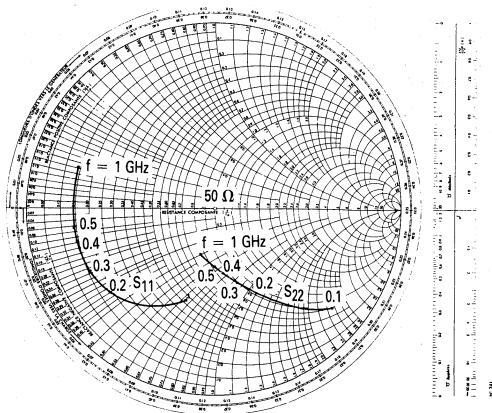
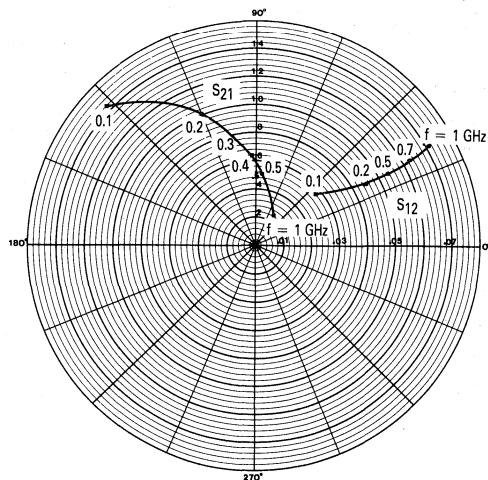
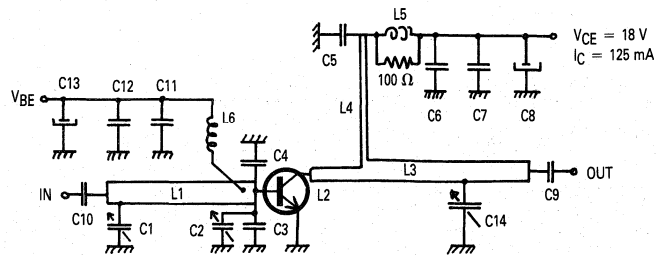


Figure 2. Noise Figure versus Collector Current

Figure 3. S_{22} — S_{11} Parameters versus Frequency
 $V_{CE} = 15\text{ V}$
 $I_C = 125\text{ mA}$ Figure 4. S_{21} — S_{12} Parameters versus Frequency
 $V_{CE} = 15\text{ V}$
 $I_C = 125\text{ mA}$



- L1 — 50 Ω line $l = 10\%$ λ_g at 860 MHz
 L2 — 100 Ω line $l = 12\%$ λ_g at 860 MHz
 L3 — 50 Ω line $l = 7\%$ λ_g at 860 MHz
 L4 — 120 Ω line $l = 10\%$ λ_g at 860 MHz
 L5 — 6 turns ID 3 mm wire 0.5 mm
 L6 — 6 turns ID 3 mm wire 0.5 mm
- C1, C2, C14 — variable AIRTRONIC C max 4.7 pF AT 7275
 C3, C4 — ATC chip 10 pF
 C5 — 680 pF ATC chip
 C6, C11 — 1 nF
 C7, C12 — 10 nF
 C8 — 10 μ F 63 V
 C13 — 10 μ F 25 V
 C9, C10 — 1 nF chip

Figure 5. 860 MHz Test Fixture

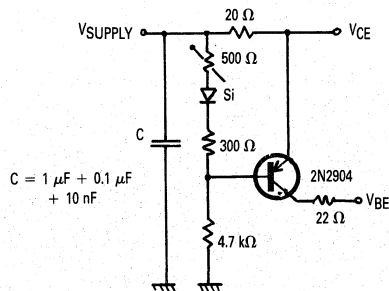


Figure 6. Bias Circuit

The RF Line

UHF Linear Power Transistors

The TP3401/S are NPN transistors, gold metallized for reliability. They use diffused emitter ballast resistors for linearity and ruggedness.

The transition frequency of 5 GHz makes these transistors ideal for UHF broadband linear amplification such as in high level 1.2 Volts MATV amplifiers up to 860 MHz, low power TV transposer stages or instrumentation.

- High Output — 1.2 V (DIN 45004/B)
- 5 GHz f_T
- High Gain — 16 dB Typ @ 500 MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Collector-Base Voltage	V_{CBO}	24	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	5	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 5\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	24	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 9\text{ V}$, $I_B = 0$)	I_{CEO}	—	—	0.6	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 50\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	70	—	190	—
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DYNAMIC CHARACTERISTICS

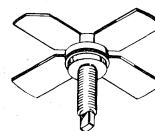
Output Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	3.5	4.5	pF
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FUNCTIONAL TESTS

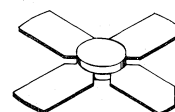
Cutoff Frequency ($V_{CE} = 12.5\text{ V}$, $I_C = 150\text{ mA}$, $f = 500\text{ MHz}$)	f_T	4.5	5	—	GHz
Maximum Unilateral Gain ($V_{CE} = 12.5\text{ V}$, $I_C = 150\text{ mA}$, $f = 500\text{ MHz}$)	G_{UMAX}	15	16.3	—	dB
Insertion Gain ($V_{CE} = 12.5\text{ V}$, $I_C = 150\text{ mA}$, $f = 500\text{ MHz}$)	$|S_{21}|^2$	12.5	14	—	dB
Intermodulation Distortion 3 Tone — DIN 45004/B ($f_{vision} = 800\text{ MHz}$, $R_{Load} = 75\text{ Ohms}$, $V_{CE} = 12.5\text{ V}$, $I_C = 150\text{ mA}$, $V_{out} = 1.2\text{ V}$)	IMD	—	-60	-58	dB

TP3401 TP3401S

UHF LINEAR POWER TRANSISTORS



.280 SOE
CASE 244C-01, STYLE 1
TP3401



.280 SOE S
CASE 249A-01, STYLE 1
TP3401S

TYPICAL CHARACTERISTICS

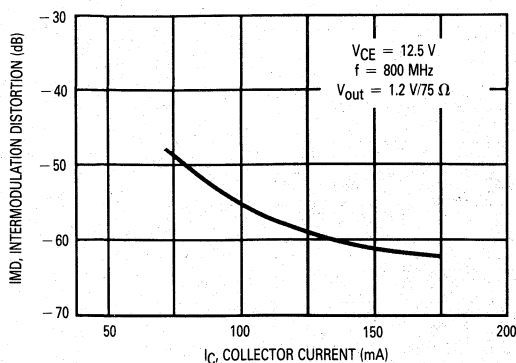


Figure 1. 3rd Order Intermodulation
(DIN 45004 B)

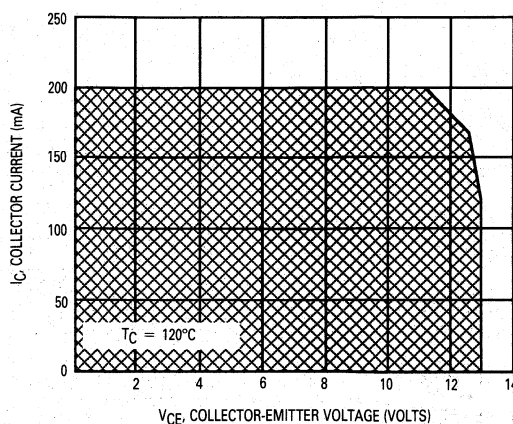


Figure 3. DC Safe Operating Area

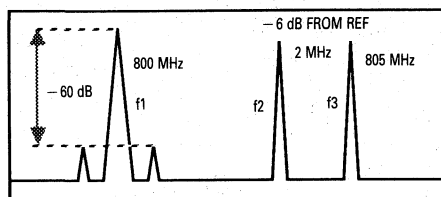


Figure 2. Intermodulation Distortion Test

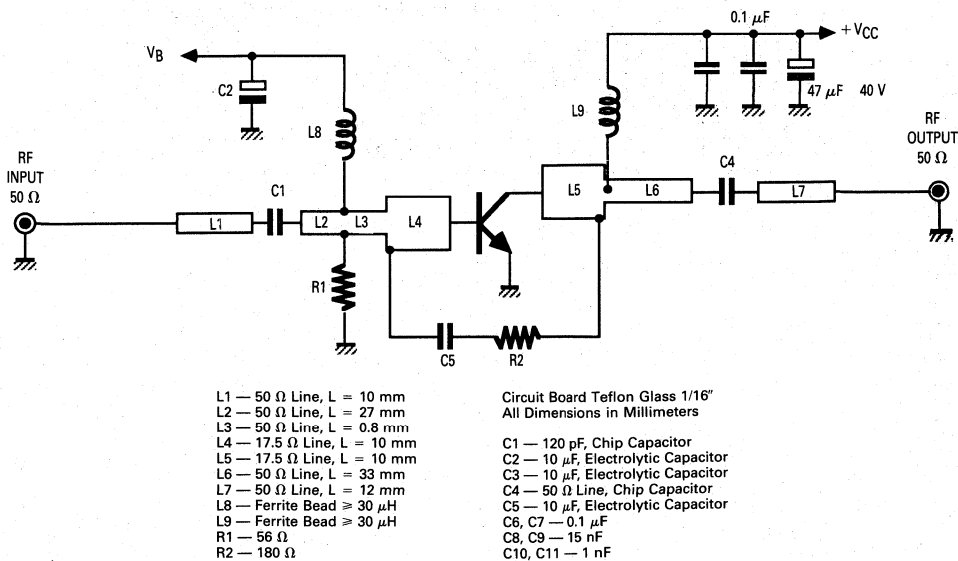


Figure 4. 800 MHz Test Circuit

S-PARAMETERS (TYPICAL)

 $V_{CE} = 7.5 \text{ V}$, $I_C = 100 \text{ mA}$, $Z_0 = 50 \Omega$, $T_C = 25^\circ\text{C}$

F (MHz)	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
200	0.605	-156.9	10.19	+92.1	0.046	42.8	0.437	-137.7
300	0.636	-167.6	7.52	80.9	0.059	46.1	0.438	-149.2
400	0.600	-174.9	5.56	72.6	0.070	47.9	0.415	-155.1
500	0.585	-179.0	4.68	66.1	0.083	49.1	0.426	-157.5
600	0.562	+177.2	4.02	60.0	0.095	49.4	0.396	-158.7
700	0.536	+174.5	3.45	53.9	0.107	48.7	0.402	-159.3
800	0.535	+171.6	3.02	47.1	0.118	45.9	0.399	-159.5
900	0.517	+169.5	2.78	39.8	0.131	43.8	0.392	-159.6
1000	0.504	+167.7	2.43	33.4	0.149	40.1	0.397	-159.6

 $V_{CE} = 12.5 \text{ V}$, $I_C = 150 \text{ mA}$, $Z_0 = 50 \Omega$, $T_C = 25^\circ\text{C}$

F (MHz)	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
200	0.559	-156.8	10.8	93.8	0.044	43.5	0.38	-136.3
300	0.594	-166.9	7.807	84.5	0.058	47.2	0.395	-147.5
400	0.584	-173.8	6.138	74.1	0.069	48.5	0.385	-152.9
500	0.561	-177.9	5.046	67.3	0.08	49.6	0.375	-155.1
600	0.546	+178.3	4.345	61.0	0.094	49.6	0.369	-156.5
700	0.515	+175.8	3.648	54.7	0.103	48.9	0.372	-156.0
800	0.514	+173.0	3.217	4.8	0.113	46.2	0.369	-155.8
900	0.502	+170.0	3.000	40.9	0.129	44.0	0.364	-155.5
1000	0.484	+169.1	2.812	34.2	0.145	40.4	0.368	-154.9

TP3402

Advance Information

The RF Line

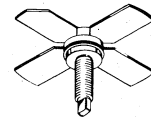
UHF Linear Power Transistor

The TP3402 is an NPN transistor gold metallized for reliability. It uses diffused emitter ballast resistors for linearity and ruggedness.

The transition frequency of 5 GHz makes this transistor ideal for UHF broadband linear amplification such as in high level 1.2 Volts MATV amplifiers up to 860 MHz, low power TV transposer stages or instrumentation.

- High Output — 1.6 V (DIN45004B)
- 5 GHz f_T
- High Gain — 16 dB Typ @ 500 MHz
- Gold Metallization for Reliability

**1.6 VOLT/75 OHMS
500 MHz
UHF LINEAR
POWER TRANSISTOR**



**.280 SOE
CASE 244C-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Collector-Base Voltage	V_{CBO}	24	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	9.5 0.048	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	21	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 2\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	24	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 9\text{ V}$, $I_B = 0$)	I_{CEO}	—	—	1.2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	70	—	190	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	7	9	pF
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FUNCTIONAL TESTS

Cutoff Frequency ($V_{CE} = 12.5\text{ V}$, $I_C = 300\text{ mA}$, $f = 500\text{ MHz}$)	f_T	4.5	5	—	GHz
Maximum Unilateral Gain ($V_{CE} = 12.5\text{ V}$, $I_C = 300\text{ mA}$, $f = 500\text{ MHz}$)	G_{UMAX}	15	16	—	dB

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Cutoff Frequency ($V_{CE} = 12.5\text{ V}$, $I_C = 300\text{ mA}$, $f = 500\text{ MHz}$)	f_T	4.5	5	—	GHz
Maximum Unilateral Gain ($V_{CE} = 12.5\text{ V}$, $I_C = 300\text{ mA}$, $f = 500\text{ MHz}$)	$G_{U_{MAX}}$	15	16	—	dB
Insertion Gain ($V_{CE} = 12.5\text{ V}$, $I_C = 300\text{ mA}$, $f = 500\text{ MHz}$)	$|S_{21}|^2$	9	10.5	—	dB
Intermodulation Distortion 3 Tone — DIN45004/B ($f_{\text{vision}} = 800\text{ MHz}$, $R_{\text{load}} = 75\text{ Ohms}$, $V_{CE} = 12.5\text{ V}$, $I_C = 300\text{ mA}$, $V_{\text{out}} = 1.6\text{ V}$)	IMD	—	−60	−58	dB

The RF Line

UHF Linear Power Transistors

The TP5002/S are NPN gold metallized transistors using diffused ballast resistors for reliability and ruggedness. They are specifically designed as low power drivers, having high gain and can be operated in Class A, B or C.

- 380–512 MHz
- 1.5 W — P_{out}
- 24 V — V_{CC}
- High Gain — 13 dB Min, Class A @ 470 MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	7 0.045	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	21	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Base Breakdown Voltage ($I_C = 1\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $R_{BE} = 75\ \Omega$)	$V_{(BR)CER}$	45	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 24\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	15	—	120	—
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DYNAMIC CHARACTERISTICS

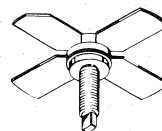
Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	4.5	pF
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FUNCTIONAL TESTS

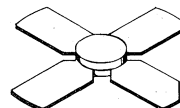
Common-Emitter Amplifier Power Gain ($V_{CE} = 23\text{ V}$, $P_{out} = 1.5\text{ W}$, $f = 470\text{ MHz}$, $I_C = 200\text{ mA}$)	G_{PE}	13	—	—	dB
Saturated Output Power ($V_{CE} = 23\text{ V}$, $f = 470\text{ MHz}$, $I_C = 200\text{ mA}$)	P_{sat}	—	2.2	—	W

TP5002
TP5002S

1.5 W — 380 to 512 MHz
UHF LINEAR
POWER TRANSISTORS



.280 SOE
CASE 244C-01, STYLE 1
TP5002



.280 SOE S
CASE 249A-01, STYLE 1
TP5002S

TYPICAL CHARACTERISTICS

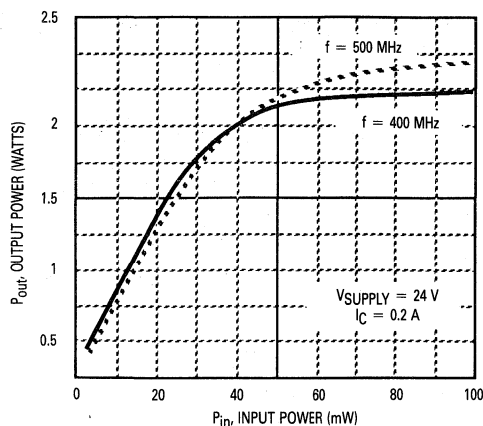


Figure 1. Output Power versus Input Power

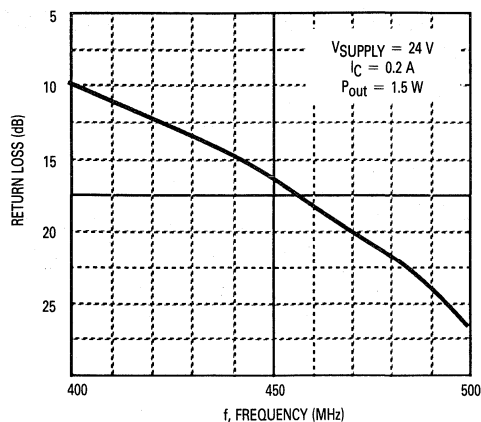


Figure 2. Return Loss versus Frequency

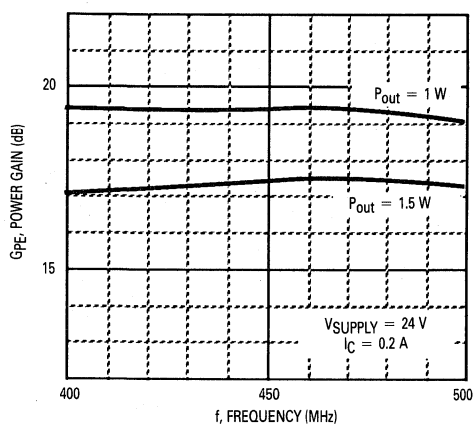


Figure 3. Power Gain versus Frequency

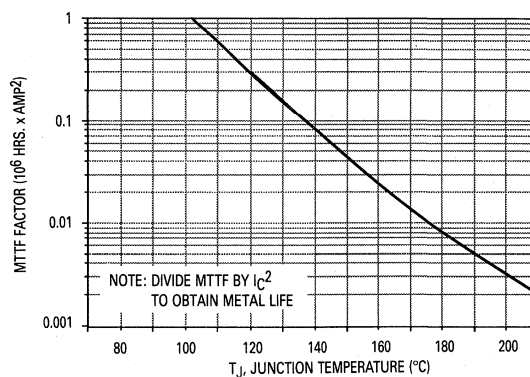


Figure 4. MTTF Factor versus Junction Temperature

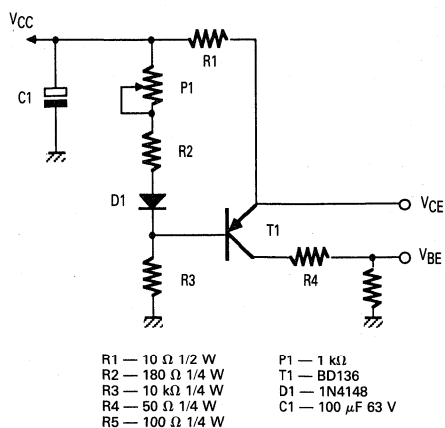


Figure 5. Class A Bias Circuit

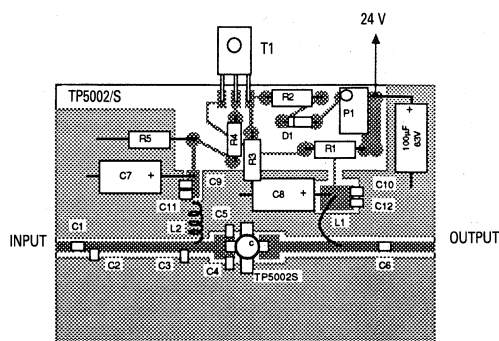
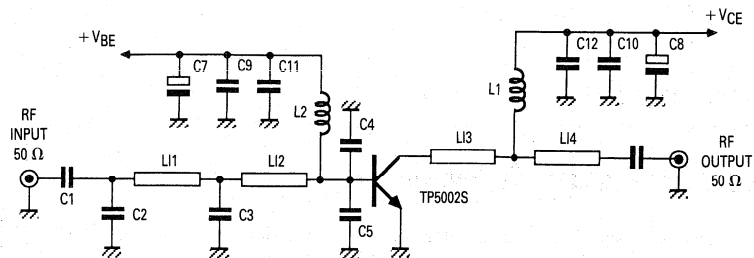


Figure 6. Component Layout



C1, C6 — 220 pF 0805 681C Sprague
 C2 — 8.2 pF ATC100A8R2DP50
 C3 — 10 pF ATC100A100DP50
 C4, C5 — 27 pF ATC100A8R2DP50
 C7 — 10 μ F 35 V
 C8 — 100 μ F 63 V
 C9, C10 — 1 nF 0805 681C Sprague
 C11, C12 — 220 pF 0805 681C Sprague

L1 — Microstrip Line $W = 2.5$ mm $Z_0 = 70$ Ω , $L = 6\%$ λ_g at 470 MHz
 L2 — Microstrip Line $W = 2.5$ mm $Z_0 = 70$ Ω , $L = 3\%$ λ_g at 470 MHz
 L3 — Microstrip Line $W = 2.5$ mm $Z_0 = 70$ Ω , $L = 5\%$ λ_g at 470 MHz
 L4 — Microstrip Line $W = 2.5$ mm $Z_0 = 70$ Ω , $L = 3\%$ λ_g at 470 MHz

Board Material: 1/16 In. Teflon Glass, $\epsilon_r = 2.55$, $h = 1.59$ mm

L1 — Hairpin wire 1.1 mm $L = 33$ mm
 L2 — 4 turns, ID 2.5 mm, 0.5 mm wire

Figure 7. 400–500 MHz Broadband Amplifier

FREQUENCY (MHz)	400	410	420	430	440	450	460	470	480	490	500
RE(Z _{in}) Ω	2.5	2.5	2.5	2.3	2.4	2.3	2.2	2.2	2.1	2.1	2.0
IM(Z _{in}) Ω	2.0	2.2	2.7	3.2	3.5	3.8	3.9	4.0	4.2	4.9	5.0
RE(Z _{load}) Ω	33.4	35.5	36.5	37.0	38.4	39.5	40.4	41.4	42.4	43.4	44.4
IM(Z _{load}) Ω	48.3	48.9	49.4	49.9	50.8	50.9	51.3	51.7	52.2	52.6	53.0

Impedance Data
 $V_{CC} = 23$ Volts
 $I_C = 200$ mA
 $P_{out} = 1.5$ Watts

Advance Information

The RF Line

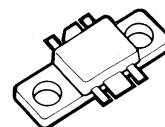
UHF Linear Power Transistor

... designed for 24 Volt UHF large-signal common emitter amplifier applications in industrial and commercial FM equipment operating in the 380 to 512 MHz frequency range, i.e., cellular radio base stations.

- 380–512 MHz
- 15 W — P_{out}
- 24 V — V_{CC}
- High Gain — 11 dB Min, Class AB
- Gold Metallization for Reliability

TP5015

**15 W — 380–512 MHz
 UHF LINEAR
 POWER TRANSISTOR**



EB
CASE 319C-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	18 0.143	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	7	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $R_{BE} = 75\ \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 26\text{ V}$, $R_{BE} = 75\ \Omega$)	I_{CER}	—	—	10	mAdc
Collector Cutoff Current ($V_{CB} = 26\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	10	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	15	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 24\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	16	24	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 24\text{ V}$, $P_{out} = 15\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 50\text{ mA}$)	G_{PE}	11	—	—	dB
Collector Efficiency ($V_{CE} = 24\text{ V}$, $P_{out} = 15\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 50\text{ mA}$)	η_c	50	60	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

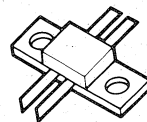
The RF Line UHF Power Transistor

... designed for 24 Volt UHF large-signal common emitter amplifier applications in industrial and commercial FM equipment operating in the 380 to 512 MHz frequency range, i.e., cellular radio base stations.

- 380–512 MHz
- 40 W — P_{out}
- 24 V — V_{CC}
- High Gain — 9 dB Min, Class AB
- Gold Metallization for Reliability

TP5040

**40 W — 380 to 512 MHz
UHF POWER
TRANSISTOR**



**BMA-2
CASE 395-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ (Note 1) Derate above 70°C	P_D	65 0.5	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	2	$^\circ\text{C/W}$

Note 1. These devices are designed for RF operation. The total dissipation rating applies only when the device is operated in an RF push-pull amplifier.

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (Note 1)

Collector-Emitter Breakdown Voltage ($I_C = 40\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 40\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 6\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $R_{BE} = 47\ \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc

ON CHARACTERISTICS (Note 1)

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 10\text{ V}$)	h_{FE}	15	120	—	—
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DYNAMIC CHARACTERISTICS (Note 1)

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	40	pF
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Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain ($V_{CE} = 24\text{ V}$, $P_{out} = 40\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 2 \times 50\text{ mA}$)	G_{PE}	9	—	—	dB
Collector Efficiency ($V_{CE} = 24\text{ V}$, $P_{out} = 40\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 2 \times 50\text{ mA}$)	η_c	45	50	—	%

Note 2. Both transistor chips operating in push-pull amplifier.

2

TYPICAL CHARACTERISTICS

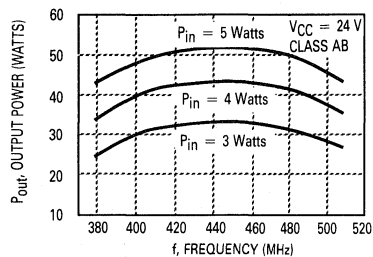


Figure 1. Output Power versus Frequency

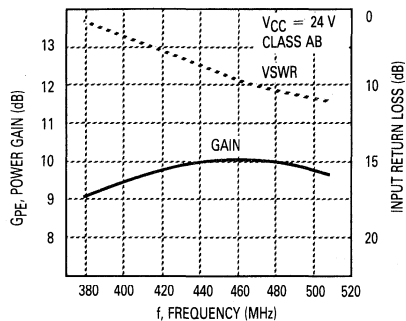


Figure 2. Gain versus Frequency

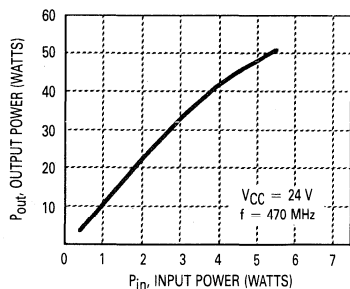
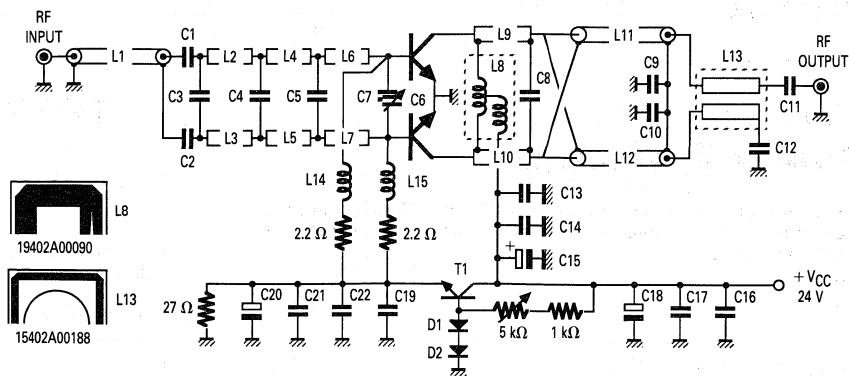


Figure 3. Output Power versus Input Power

F (MHz)	400	430	470	500
Input Impedance Ω	$2.5+j1.0$	$2.75+j2.0$	$3.0+j3.1$	$3.25+j4.25$
Load Impedance Ω	$8.5+j6.5$	$7+j6.5$	$6.0+j6.25$	$4.75+j6.0$

Figure 4. Series Equivalent Input/Load Impedances

CONDITIONS:
 $V_{CE} = 24\text{ V}$
 $I_Q = 2 \times 50\text{ mA}$ — Class AB
 $P_{out} = 40\text{ W}$
 Collector-to-Collector



L1 — 50 Ω Coaxial Cable, 20% λ_g @ 470 MHz
 L2, L3 — Wire Dia. 0.5 mm, $L = 5$ mm
 L4, L5 — Microstrip Line 7.5 mm 1679 Ω , 1.7% λ_g @ 470 MHz
 L6, L7 — Microstrip Line 7.5 mm 39 Ω , 1.7% λ_g @ 470 MHz
 L8 — Collector/Collector Inductor, 1/50" Teflon Glass
 L9, L10 — Microstrip Line 7 mm 50 Ω , 1.7% λ_g @ 470 MHz
 L11, L12 — 25 Ω Coaxial Cable, 56 mm
 L13 — Balun 60 Ω , 12.5% λ_g @ 470 MHz
 L14, L15 — 3 Turns ID 3 mm Wire 1 mm
 C1, C2, C7 — 47 pF ATC100A470JP50 Capacitor
 C3 — 4.7 pF ATC100A4R7DP50 Capacitor
 C4 — 5.6 pF ATC100A5R6DP50 Capacitor

C5 — 15 pF ATC100A150DP50 Capacitor
 C6 — Trimmer 1-4 pF/Johanson 9401-4
 C8 — 12 pF ATC100A120DP50 Capacitor
 C9 — 1 nF Chip 0805 Sprague/Vitramon Capacitor
 C10 — 15 nF Chip 0805 Sprague/Vitramon Capacitor
 C11, C12 — 100 pF ATC100A101KP50 Capacitor
 C13, C17, C21 — 100 pF ATC100A101KP50 Capacitor
 C14, C16, C22 — 10 nF 0805 Sprague/Vitramon Capacitor
 C19 — 0.1 nF 0805 Sprague/Vitramon Capacitor
 C18, C20 — 100 μ F 40 V Capacitor
 C15 — 10 μ F 63 V Capacitor
 D1, D2 — 1N4007 Diode
 T1 — BD135 Transistor

Board Material: .020 In., Teflon Glass

Figure 5. 380-512 MHz Broadband Test Circuit

The RF Line **UHF Power Transistor**

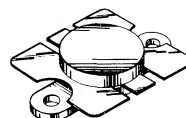
2

... designed for 24 Volt UHF large-signal common emitter amplifier applications in industrial and commercial FM equipment operating in the 440 to 470 MHz frequency range, i.e., cellular radio base stations.

- 440–470 MHz
- 50 W — P_{out}
- 28 V — V_{CC}
- Rugged
- Gold Metallization for Reliability

TP5050

**50 W — 470 MHz
 UHF POWER TRANSISTOR**



**.500 J ZERO
 CASE 316A-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	32	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	65 0.67	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	1.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	32	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	60	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 5\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	70	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 50\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 100\text{ mA}$)	G_{PE}	6.5	7	—	dB
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 50\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 100\text{ mA}$)	η_c	60	65	—	%
Load Mismatch ($V_{CE} = 28\text{ V}$, $I_Q = 100\text{ mA}$, $P_{out} = 50\text{ W}$, $f = 470\text{ MHz}$, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

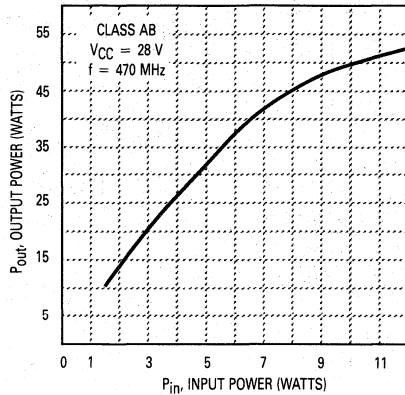


Figure 1. Output Power versus Input Power

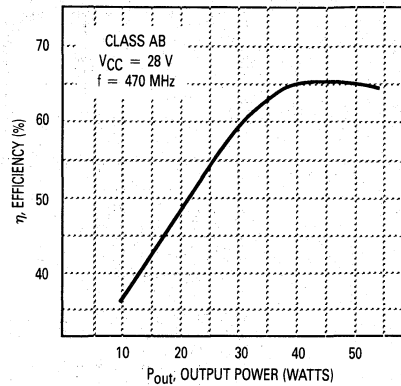


Figure 2. Efficiency versus Power Output

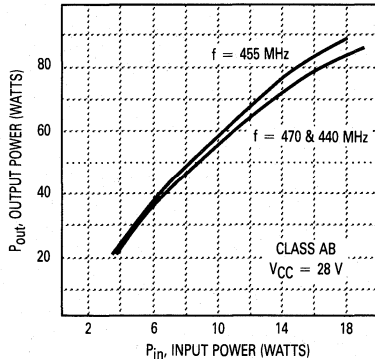


Figure 3. Output Power versus Input Power

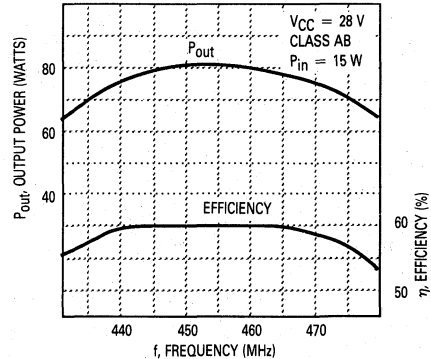


Figure 4. Output Power and Efficiency versus Frequency

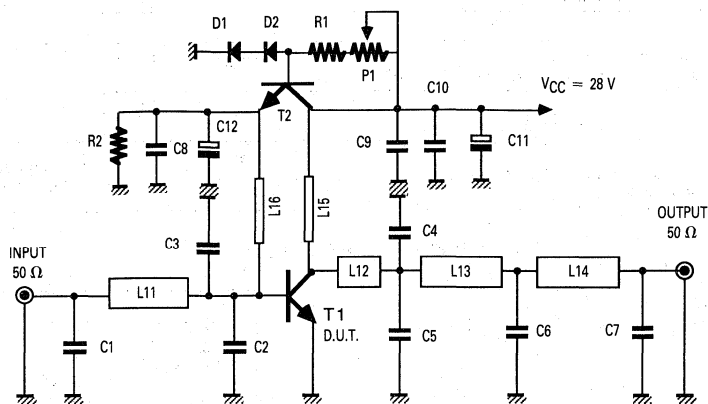


Figure 5. 440-470 MHz Test Circuit

C1 — 6.8 pF ATC100A
 C2, C4, C5 — 39 pF ATC100A
 C3 — 27 pF ATC100A
 C6 — 15 pF ATC100A
 C7 — 8.2 pF ATC100A

C8, C9 — 1 nF Sprague
 C10 — 100 nF Sprague
 C11 — 100 μ F 63 V
 C12 — 4.7 μ F 12 V
 R1 — 2.2 k Ω R2 51 Ω
 P1 — 1 k Ω

L11 — Microstrip Line W = 3.2 mm L = 12 mm
 L12 — Microstrip Line W = 3.2 mm L = 4 mm
 L13 — Microstrip Line W = 3.2 mm L = 12 mm
 L14 — Microstrip Line W = 3.2 mm L = 22 mm
 L15 — Microstrip Line W = 1.8 mm L = 85 mm
 L16 — Microstrip Line W = 8 mm L = 70 mm
 T2 — BD135

Board Material: 1/16 Inch, Epoxy Glass, $\epsilon_r = 4.5$

Advance Information

The RF Line

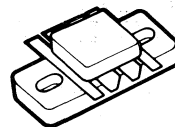
UHF Linear Power Transistor

... designed for 24–28 Volt UHF large-signal common emitter amplifier applications in industrial and commercial FM equipment operating in the 430 to 470 MHz frequency range, i.e., cellular radio base stations.

- 430–470 MHz
- 60/50 W — P_{out}
- 28/24 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability
- Guaranteed Ruggedness at Rated P_O

TP5060

60 W — 470 MHz
UHF LINEAR
POWER TRANSISTOR



MRP 7
CASE 827-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ (Note 1) Derate above 70°C	P_D	160 1.43	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–60 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	0.7	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (Note 2)

Collector-Emitter Breakdown Voltage ($I_C = 45\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 45\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 45\text{ mA}$, $R_{BE} = 15\ \Omega$)	$V_{(BR)CER}$	55	—	—	Vdc

ON CHARACTERISTICS (Note 2)

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 28\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS (Note 2)

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	60	—	pF
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Notes: 1. These devices are designed for RF operation. The total dissipation rating applies only when the devices are operated as RF push-pull amplifiers.

2. Each transistor chip measured separately.

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 1)					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 2 \times 100\text{ mA}$)	G_{PE1}	6.5	7	—	dB
Common-Emitter Amplifier Power Gain ($V_{CE} = 24\text{ V}$, $P_{out} = 50\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 2 \times 100\text{ mA}$)	G_{PE2}	6	6.5	—	dB
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 470\text{ MHz}$, $I_Q = 2 \times 100\text{ mA}$)	η_c	45	50	—	%
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 60\text{ W}$, $f = 470\text{ MHz}$, Load VSWR = 25:1, All Phase Angles)	ψ	No Degradation in Output Power			

Note 1. Both transistor chips operating in push-pull amplifier.

The RF Line

VHF Power Transistors

The TP8828/F has been specifically designed and characterized for 12.5 V operation in 175 MHz amplifiers.

It can be operated under Class B or C and is able to withstand infinite VSWR at all phase angles at rated output power.

- 175 MHz
- 10 W — P_{out}
- 12.5 V — V_{CC}
- High Gain — 11 dB Min

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	3.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 0.29	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	2	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	—	—
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DYNAMIC CHARACTERISTICS

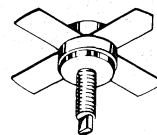
Output Capacitance ($V_{CB} = 15\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	25	30	pF
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FUNCTIONAL TESTS

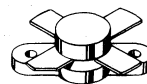
Common-Emitter Amplifier Power Gain ($V_{CE} = 12.5\text{ V}$, $P_{out} = 9\text{ W}$, $f = 175\text{ MHz}$)	G_{PE}	11.1	—	—	dB
Collector Efficiency ($V_{CE} = 12.5\text{ V}$, $P_{out} = 9\text{ W}$, $f = 175\text{ MHz}$)	η_c	60	—	—	%
Load Mismatch ($V_{CE} = 12.5\text{ V}$, $P_{out} = 9\text{ W}$, $f = 175\text{ MHz}$, Load VSWR — $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			

TP8828
TP8828F

10 W — 175 MHz
VHF POWER
TRANSISTORS



.380 SOE
CASE 145D-01, STYLE 1
TP8828



.380 SOE F
CASE 211-07, STYLE 1
TP8828F

The RF Line **VHF Power Transistor**

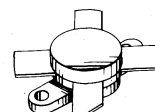
... designed for use in the new generation of VHF-FM broadcast transmitters operating from a 28 V supply in Class A, B or C.

Its construction, which now incorporates gold metallization and diffused ballast resistors, ensures a long operational life even when run at its maximum ratings.

- 108 MHz
- 75 W — P_{out}
- 28 V — V_{CC}
- High Gain — 11 dB, Class C
- Gold Metallization for Improved Reliability
- Diffused Emitter Ballast Resistors for Ruggedness

TP9380

**75 W to 108 MHz
VHF POWER
TRANSISTOR**



**.500 SOE F
CASE 211-11, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 70°C	P_D	100 0.67	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	60	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 30\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	85	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 75\text{ W}$, $f = 108\text{ MHz}$)	G_{PE}	10.3	—	—	dB
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 75\text{ W}$, $f = 108\text{ MHz}$)	η_c	70	75	—	%
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 75\text{ W}$, $f = 108\text{ MHz}$, Load VSWR = 4:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

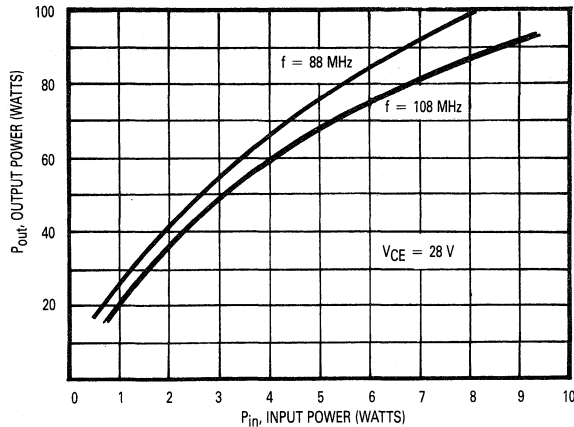


Figure 1. Power Output versus Power Input

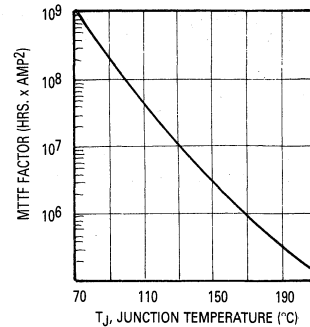


Figure 2. MTTF Factor versus Junction Temperature

Note: Divide by I_C^2 to obtain metal lifetime in hours

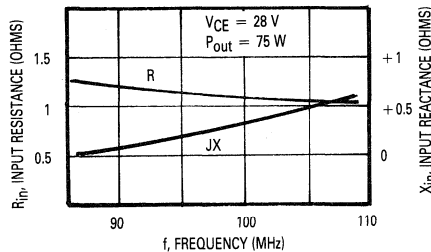


Figure 3. Series Input Impedance versus Frequency

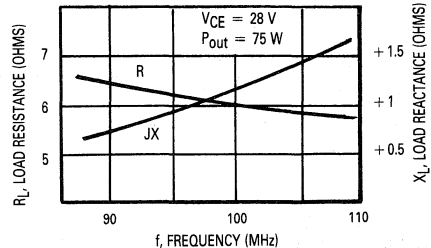


Figure 4. Series Load Impedance versus Frequency

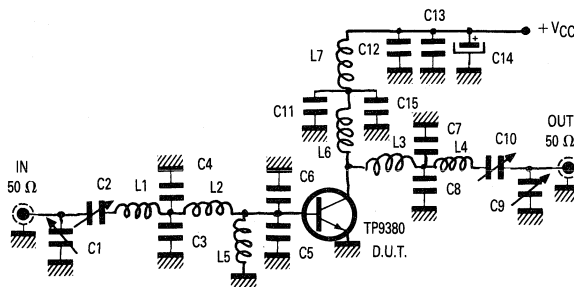


Figure 5. 88–108 MHz Narrowband Test Fixture

- C1 — Arco 425 Variable capacitor (24–200 pF)
- C2 — Arco 425 Variable capacitor (24–200 pF)
- C3 — 60 pF UNELCO
- C4 — 60 pF UNELCO (108 MHz)
- C5 — 330 pF chip capacitor (closed to the transistor)
- C6 — 330 pF chip capacitor (closed to the transistor)
- C7 — 40 pF UNELCO
- C8 — 40 pF UNELCO (108 MHz)
- C9 — Arco 423 Variable capacitor (7–100 pF)
- C10 — Arco 425 Variable capacitor (24–200 pF)
- C11 — 1000 pF UNELCO
- C12 — 1000 pF UNELCO
- C13 — 0.1 μ F disc capacitor
- C14 — 100 μ F/40 V capacitor
- C15 — 10 nF disc capacitor
- L1 — 3 turns ID = 6 mm 1 mm wire
- L2 — « Hair pin » made with a 1.4 mm wire L = 15 mm
- L3 — « Hair pin » made with a 2 mm wire L = 20 mm for 108 MHz
- L4 — 3 turns ID = 8 mm 1.4 mm wire
- L5 — 0.7 μ H choke
- L6 — 6 turns ID = 6 mm 1.2 mm wire L = 15 mm
- L7 — 4 turns 1.2 mm wire on ferrite

The RF Line **VHF Power Transistor**

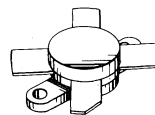
... designed for use in the new generation of VHF-FM broadcast transmitters operating from a 28 V supply in Class A, B or C.

Its construction, which now incorporates gold metallization and diffused ballast resistors, ensures a long operational life even when run at its maximum ratings.

- 108 MHz
- 150 W — P_{out}
- 28 V — V_{CC}
- High Gain — 10 dB Typ
- Gold Metallization for Reliability
- Diffused Emitter Ballast Resistors for Ruggedness

TP9383

**150 W — 108 MHz
VHF POWER
TRANSISTOR**



**.500 SOE F
CASE 211-11, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 70°C	P_D	150 1	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	1	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 20\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	55	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	150	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28 \text{ V}$, $P_{out} = 150 \text{ W}$, $f = 108 \text{ MHz}$)	G_{PE}	9.2	—	—	dB
Collector Efficiency ($V_{CE} = 28 \text{ V}$, $P_{out} = 150 \text{ W}$, $f = 108 \text{ MHz}$)	η_C	70	75	—	%
Load Mismatch ($V_{CE} = 28 \text{ V}$, $P_{out} = 150 \text{ W}$, $f = 108 \text{ MHz}$, Load VSWR = 4:1, All Phase Angles) ($V_{CE} = 28 \text{ V}$, $P_{out} = 100 \text{ W}$, $f = 108 \text{ MHz}$, Load VSWR = ∞ :1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

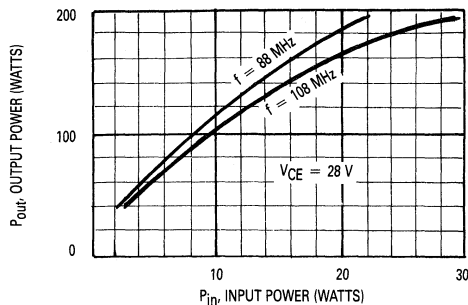


Figure 1. Output Power versus Input Power

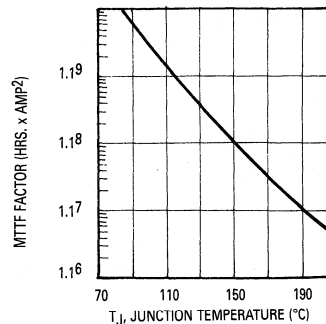


Figure 2. MTTF Factor versus Junction Temperature

NOTE: Divide by I_C^2 to obtain metal lifetime in hours

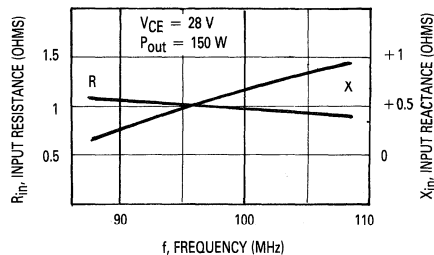


Figure 3. Series Input Impedance versus Frequency

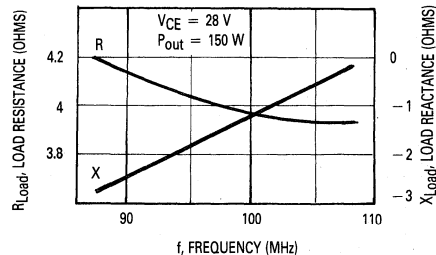


Figure 4. Series Load Impedance versus Frequency

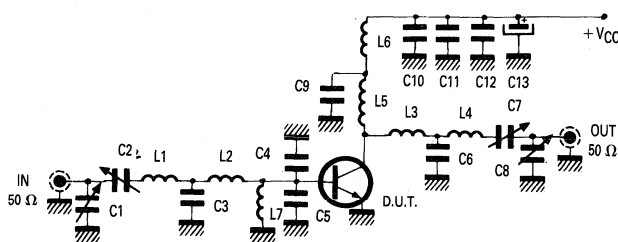


Figure 5. 108 MHz Test Circuit

- C1 — Arco 425 Variable capacitor 24–200 pF
- C2 — Arco 425
- C3 — 150 pF UNELCO
- C4 — 470 pF Chip capacitor (very close to the transistor) ATC
- C5 — 470 pF Chip capacitor (very close to the transistor) ATC
- C6 — 300 pF UNELCO
- C7 — ARCO 425
- C8 — ARCO 425
- C9 — 1000 pF UNELCO
- C10 — 1000 pF UNELCO
- C11 — 10000 pF
- C12 — 0.1 μF
- C13 — 100 μF /40 V electrolytic

- L1 — 3 turns 6 mm ID 1.2 mm wire
- L2 — 2 cm wire 1.2 mm Ω (hair pin)
- L3 — 1.2 cm wire 1.2 mm Ω (hair pin)
- L4 — 3 turns 6 mm ID 1.2 mm wire
- L5 — 6 turns 8 mm ID 1.5 mm wire
- L6 — 6 turns 1.5 mm wire on ferrite core
- L7 — 10 μF choke

The RF Line **VHF Power Transistor**

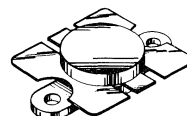
... designed for use in VHF transmitters. Operation is in Class A, B or C from a 28 V supply.

Construction, which now incorporates gold metallization and diffused ballast resistors, ensures a long operational life even when run at its maximum ratings.

- 100–175 MHz
- 150 W — P_{out}
- 28 V — V_{CC}
- High Gain — 10 dB Min @ $f = 175$ MHz
- Gold Metallization for Reliability
- Diffused Emitter Ballast Resistors for Ruggedness

TP9386

**150 W — 175 MHz
VHF POWER
TRANSISTOR**



**.500 J ZERO
CASE 316A-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 70°C	P_D	250 1.43	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 20$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $R_{BE} = 10$ Ω)	$V_{(BR)CER}$	60	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	15	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	150	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 28$ V, $P_{out} = 150$ W, $f = 175$ MHz, $I_Q = 50$ mA)	G_{PE}	10	—	—	dB
Collector Efficiency ($V_{CE} = 28$ V, $P_{out} = 150$ W, $f = 175$ MHz, $I_Q = 50$ mA)	η_c	60	—	—	%

TYPICAL CHARACTERISTICS

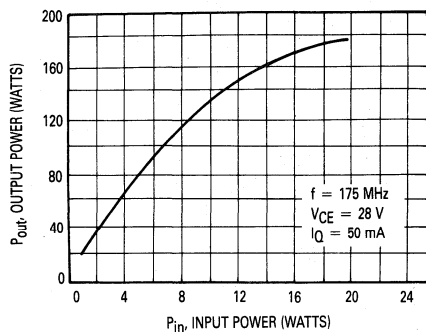


Figure 1. Output Power versus Input Power

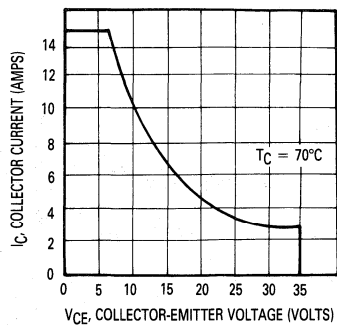
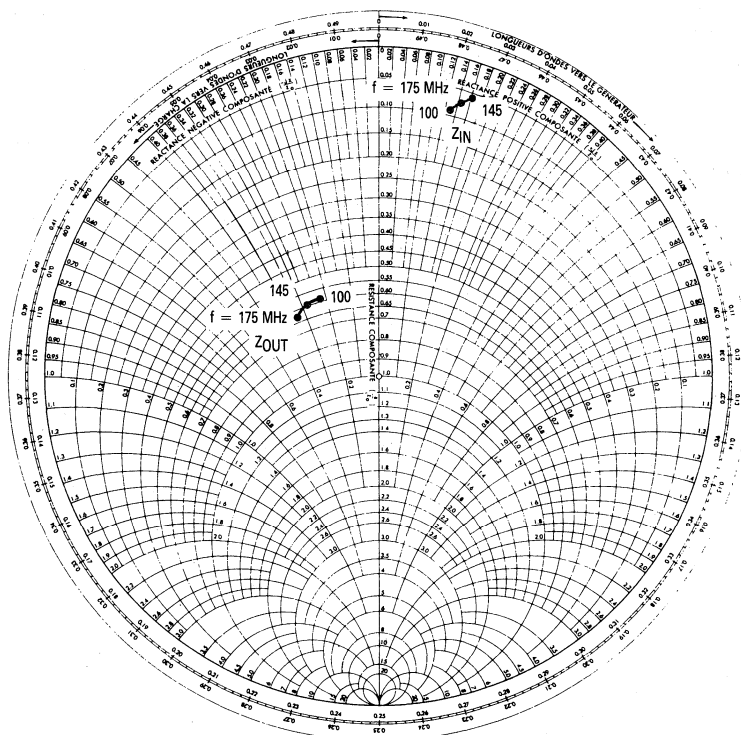


Figure 2. DC Safe Operating Area

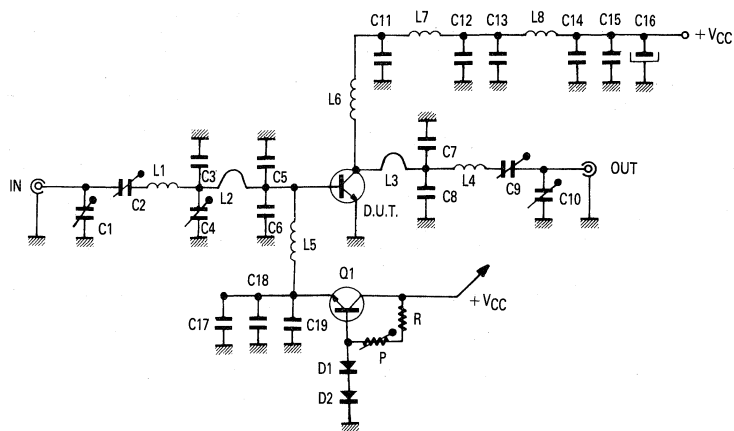


Conditions

 $V_{CE} = 28 \text{ V}, I_Q = 50 \text{ mA}, P_{out} = 150 \text{ W}$

f (MHz)	$Z_{in} (\Omega)$	$Z_{out} (\Omega)$
100	$0.43 + j0.65$	$2.88 - j1.13$
145	$0.40 + j0.7$	$2.88 - j1.22$
175	$0.29 + j0.87$	$3.16 - j1.39$

Figure 3. Series Equivalent Input/Output Impedances



C1, C2 — ARCO 403
 C3 — 30 pF
 C4 — ARCO 404
 C5, C6 — 80 pF
 C7, C8 — 100 pF
 C9, C10 — ARCO 425 (24–200 pF)
 C11, C12, C14, C17 — 1000 pF
 C13, C15, C18 — 10 nF
 C16, C19 — 47 μ F

L1 — 2 turns, ϕ 8 mm 1 mm wire
 L2 — Hair pin, Copper foil 15 x 3 mm, 0.3 mm thick
 L3 — Hair pin, Copper foil 12 x 5 mm, 0.3 mm thick
 L4 — 3 turns, ϕ 5 mm, 1.5 mm wire
 L5 — 10 turns, ϕ 5 mm, 0.5 mm wire
 L6 — 3 turns, ϕ 6 mm, 1.5 mm wire
 L7 — 3 turns, ϕ 6 mm, 1.5 mm wire
 L8 — 10 turns, 1 mm wire on core ($\mu_i = 120$)

R — 1.5 Ω 1/2 W

P — 5 k Ω

D1, D2 — 1N4007

Q1 — BD135

Figure 4. 175 MHz Test Fixture

Advance Information

The RF Line

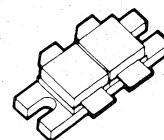
VHF Power Transistor

... designed for use in VHF-FM transmitters operating from a 24 or 28 Volt supply. Gold metallization, diffused emitter ballast resistors and push-pull package technology are combined to provide reliability and ruggedness.

- 88–108 MHz
- 250 W — P_{out}
- 28 V — V_{CC}
- High Gain — 11 dB Min @ 108 MHz
- Gold Metallization for Reliability
- Push-Pull Package

TP9390

250 W — 108 MHz
VHF POWER
TRANSISTOR



HPA-1
CASE 397-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ (Note 1) Derate above 25°C	P_D	420 2.22	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	0.45	$^\circ\text{C/W}$

Note 1. These devices are designed for RF operation. The total dissipation rating applies only when the device is operated in an RF push-pull amplifier.

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (Note 1)

Collector-Emitter Breakdown Voltage ($I_C = 200\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 200\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 40\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS (Note 1)

DC Current Gain ($I_C = 2\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS (Note 1)

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	140	150	pF
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FUNCTIONAL TESTS (Note 2)

Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 250\text{ W}$, $f = 108\text{ MHz}$)	G_{PE}	11	—	—	dB
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 250\text{ W}$, $f = 108\text{ MHz}$)	η_c	70	—	—	%

Notes: 1. Each transistor chip measured separately.
2. Both transistor chips operating in a push-pull amplifier.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

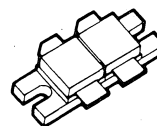
The RF Line VHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 30 to 200 MHz frequency range.

- Designed for Class AB Linear Power Amplifiers
- Specified 28 Volt, 162 MHz Characteristics:
 - Output Power — 130 Watts
 - Power Gain — 9 dB Min, Class AB
 - Collector Efficiency — 60% Typ
- Push-Pull Package Construction
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

TPA0102-130

9 dB
30–200 MHz
130 WATTS
BROADBAND
VHF POWER
TRANSISTOR



HLP-50
CASE 390-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous (Note 1)	I_C	12	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	– 65 to + 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.48	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS (Note 1)

Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 25$ V, $V_{BE} = 0$)	I_{CES}	—	—	10	mAdc

ON CHARACTERISTICS (Note 1)

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS (Note 1)

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	200	pF
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Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 130\text{ W}$, $f = 162\text{ MHz}$, $I_{CQ} = 2 \times 120\text{ mA}$)	G_{PE}	9	—	—	dB
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 130\text{ W}$, $f = 162\text{ MHz}$, $I_{CQ} = 2 \times 120\text{ mA}$)	η_c	—	60	—	%
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 130\text{ W}$, $f = 100\text{ MHz}$, Load VSWR = 5:1, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 28\text{ V}$, $f = 162\text{ MHz}$)	P_{sat}	150	—	—	W

Note 2. Both transistor chips operating in push-pull amplifier.

TYPICAL CHARACTERISTICS

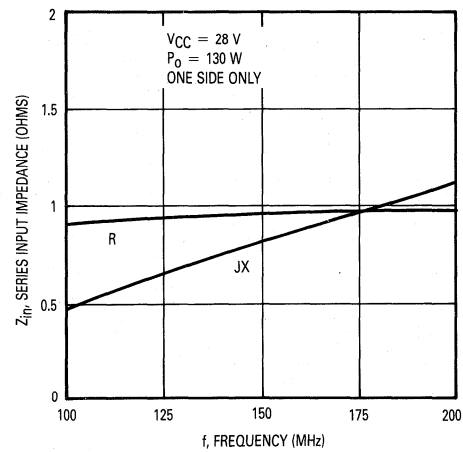


Figure 1. Input Impedance versus Frequency

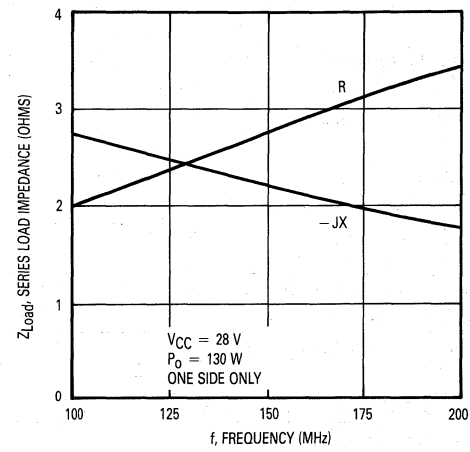


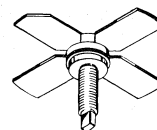
Figure 2. Load Impedance versus Frequency

The RF Line

UHF Power Transistor

TPM401

1 W — 400 MHz
UHF POWER TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

... designed as an NPN gold metallized transistor using diffused emitter ballast resistors for operation in Class A, B or C conditions.

The high gain reduces the need for complex broadband circuits and is ideally suited for 100–400 MHz broadband amplifier applications.

- 100–400 MHz
- 1 W — P_{out}
- 20 V — V_{CC}
- High Gain — 13 dB Min @ $f = 400$ MHz
- Diffused Emitter Ballast Resistors for Ruggedness
- Gold Metallization for Reliability

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.7	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	8.75 0.05	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_{case} = 70^\circ\text{C}$)	$R_{\theta JC}$	20	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_B = 0$)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.3$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $R_{BE} = 10 \Omega$)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	I_{CBO}	—	—	0.4	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mA, $V_{CE} = 5$ V)	h_{FE}	20	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 24$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	5	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain — Class A ($V_{CE} = 20\text{ V}$, $P_{out} = 0.5\text{ W}$, $f = 400\text{ MHz}$, $I_E = 200\text{ mA}$)	G_{PE}	13	—	—	dB
Load Mismatch ($V_{CE} = 20\text{ V}$, $P_{out} = 1\text{ W}$, $I_C = 220\text{ mA}$, $f = 400\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power — Class A ($f = 400\text{ MHz}$, $V_{CE} = 20\text{ V}$, $I_E = 200\text{ mA}$)	P_{sat}	1.3	—	—	W
Cutoff Frequency ($V_{CE} = 20\text{ V}$, $I_E = 200\text{ mA}$)	f_T	2.2	—	—	GHz

 $V_{CE} = 20\text{ V} - I_C = 200\text{ mA} - \text{Class A}$

POLAR S-PARAMETERS IN 50 OHM SYSTEM								
F	S 11		S 21		S 12		S 22	
MHz	Magn	Angl°	Magn	Angl°	Magn	Angl°	Magn	Angl°
100 MHz	0.67	203°	12.6	112°	0.037	32°	0.41	— 90°
200 MHz	0.78	186°	7.6	93°	0.042	31°	0.33	— 122°
300 MHz	0.79	183°	5.5	82.5°	0.047	30°	0.34	— 135°
400 MHz	0.78	170°	4.21	72°	0.053	30°	0.34	— 137°
500 MHz	0.76	165°	3.39	66°	0.061	35°	0.33	— 138°

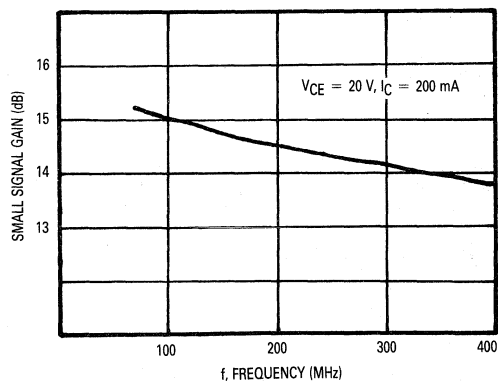
100–400 MHz AMPLIFIER PERFORMANCE
Class A 20 V 200 mA

Figure 1. Small Signal Gain Variation

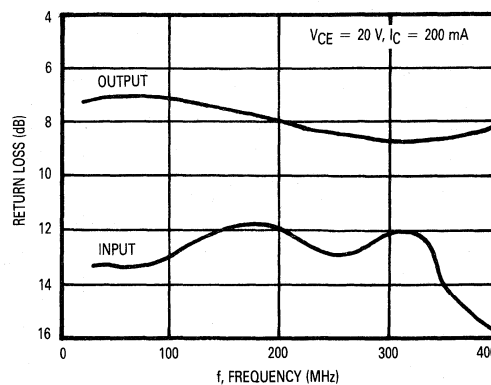


Figure 2. Input and Output VSWR

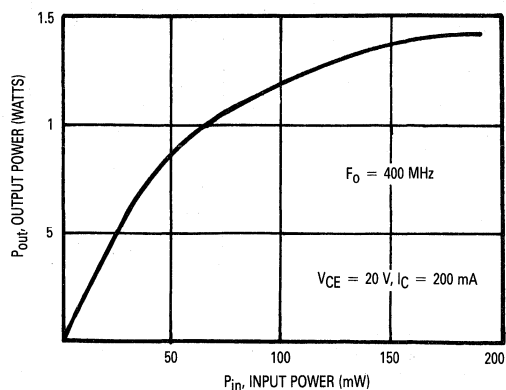


Figure 3. Output Power versus Input Power

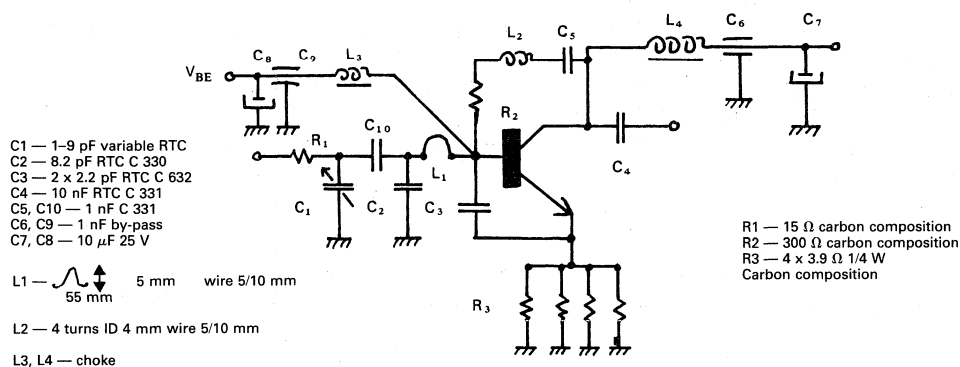


Figure 4. 1 W — 100–400 MHz Class A Amplifier

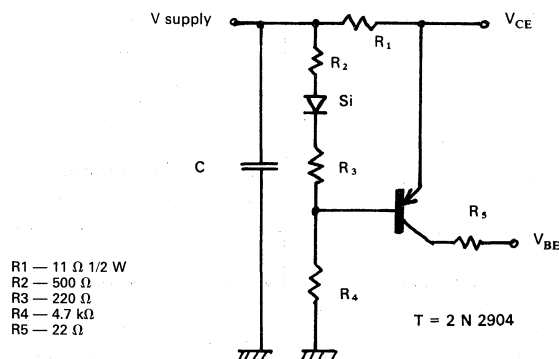


Figure 5. Bias Circuit

The RF Line

UHF Power Transistor

... designed as an NPN gold metallized transistor using diffused emitter ballast resistors for operation in Class A, AB and C.

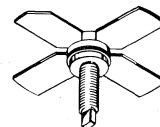
High gain reduces the complexity of the broadband stages and make the TPM405 ideal for 100–400 MHz applications.

A 100–400 MHz push-pull amplifier is described in the two last pages of this data sheet.

- 400 MHz
- 5 W — P_{out}
- High Gain — 16 dB Min @ $f = 400$ MHz
- Diffused Emitter Ballast Resistors for Ruggedness
- Gold Metallization for Reliability

TPM405

5 W — 400 MHz
UHF POWER TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	1.4	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_{case} = 70^\circ\text{C}$)	$R_{\theta JC}$	9.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Base Breakdown Voltage ($I_C = 2$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 40$ mA, $R_{BE} = 10$ Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	I_{CBO}	—	—	0.45	mA _{dc}

ON CHARACTERISTICS

DC Current Gain ($I_C = 200$ mA, $V_{CE} = 5$ V)	h_{FE}	20	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 24$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	7	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain — Class AB ($V_{CE} = 24\text{ V}$, $P_{out} = 5\text{ W}$, $f = 400\text{ MHz}$, $I_Q = 50\text{ mA}$)	G_{PE}	16	—	—	dB
Collector Efficiency ($V_{CE} = 24\text{ V}$, $P_{out} = 5\text{ W}$, $f = 400\text{ MHz}$, $I_Q = 50\text{ mA}$)	η_c	50	—	—	%
Load Mismatch ($V_{CE} = 24\text{ V}$, $P_{out} = 3\text{ W}$, $f = 400\text{ MHz}$, $I_Q = 50\text{ mA}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power ($V_{CE} = 24\text{ V}$, $f = 400\text{ MHz}$, $I_Q = 50\text{ mA}$)	P_{sat}	7	—	—	W

CLASS A - $V_{CE} = 20\text{ V}$ - $I_C = 440\text{ mA}$ - Small Signal

POLAR S-PARAMETERS IN 50 OHM SYSTEM								
F	S 11		S 21		S 12		S 22	
MHz	Magn	Angl°	Magn	Angl°	Magn	Asgl°	Magn	Angl°
100 MHz	0.871	190	6.130	108	0.028	17	0.537	205
200 MHz	0.902	182	4.9	90	.03	18	0.562	191
300 MHz	0.907	178	3.35	80	0.033	20	0.562	189
400 MHz	0.902	175	2.66	72	0.035	22	0.562	188
500 MHz	0.905	175	2.21	71	0.034	30	.540	192

Large Signal Impedances

Class AB

 $I_Q = 50\text{ mA}$ $F_0 = 400\text{ MHz}$ $P_{out} = 5\text{ W}$ $V_{CE} = 20\text{ V}$

Z_{in}	Z_{out}
(1.5 — J 1) ohm	(15.5 — J 21.4) ohm

PUSH-PULL PERFORMANCE

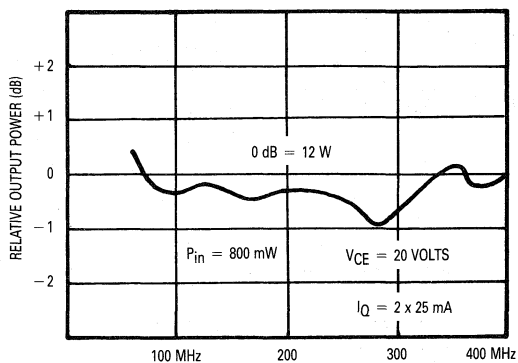


Figure 1. Output Power versus Frequency

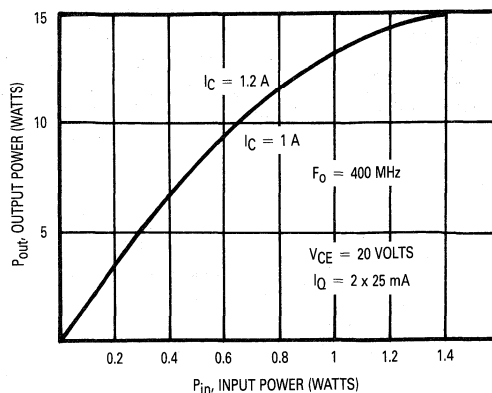


Figure 2. Output Power versus Input Power

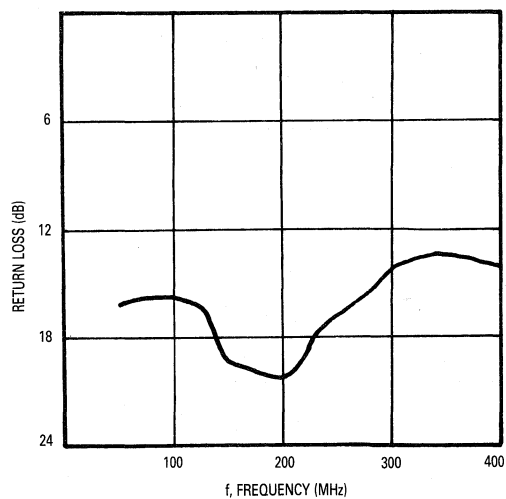
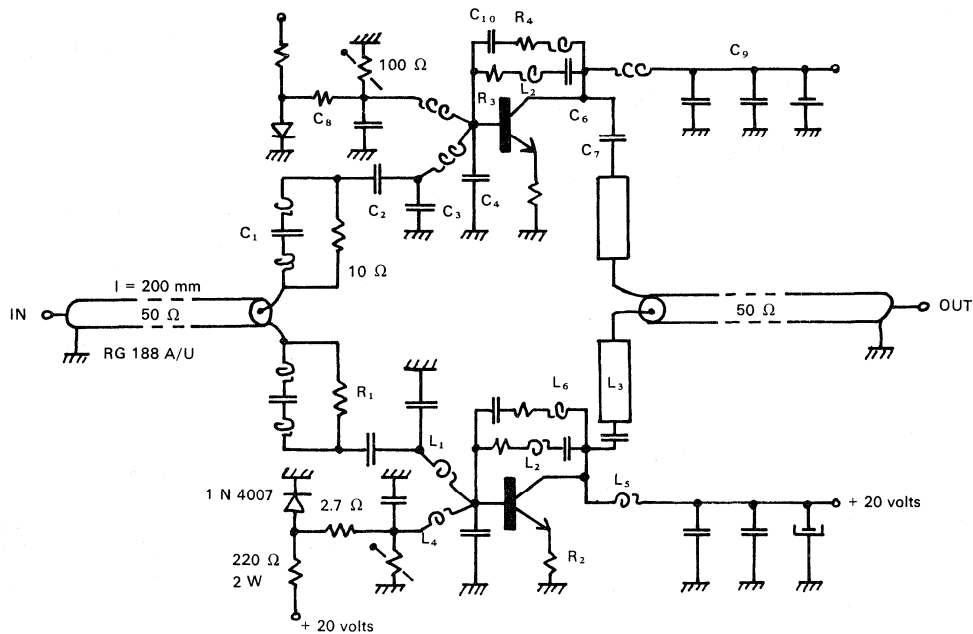


Figure 3. Input Return Loss



- L1 — 1/2 turn \sim 5 mm 5/10 mm
 L2 — 6 turns \varnothing 3 mm 5/10 mm
 L3 — 25 Ω line 2% λ_g at 400 MHz
 L4 — Moiled coil 0.47 μ F
 L5 — Moiled coil 4.7 μ H
 L6 — 17 turns \varnothing 3 mm 5/10 mm
 C1 — 27 pF C 300 RTC with 12 mm leads
 C2, C7 — 10 nF chip
 C3 — 27 pF ATC 100 A
 C4 — 2 x 1.3 pF ATC 100 A
 C6, C10 — 10 nF RTC C 331
 C8, C9 — 1 nF + 10 nF + 0.1 μ F + 10 μ F decoupling
 R1 — 10 Ω 1/4 W carbon
 R2 — 4 x 1 Ω 1/4 W carbon
 R3, R4 — 300 Ω 1/4 W carbon

Figure 4. Push-Pull Amplifier 100-400 MHz

The RF Line UHF Power Transistor

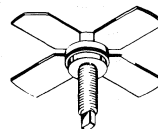
... designed for use in 100–400 MHz broadband amplifiers.

Construction utilizes the new standard, gold metallization and diffused emitter ballast resistors, allowing Class A, B or C operation and a high degree of ruggedness.

- 400 MHz
- 25 W — P_{out}
- 24 V — V_{CC}
- High Gain — 9 dB
- Diffused Emitter Ballast Resistors for Ruggedness
- Gold Metallization for Reliability

TPM425

**25 W — 400 MHz
UHF POWER TRANSISTOR**



**.280 SOE
CASE 244C-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_B = 0$)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 3$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

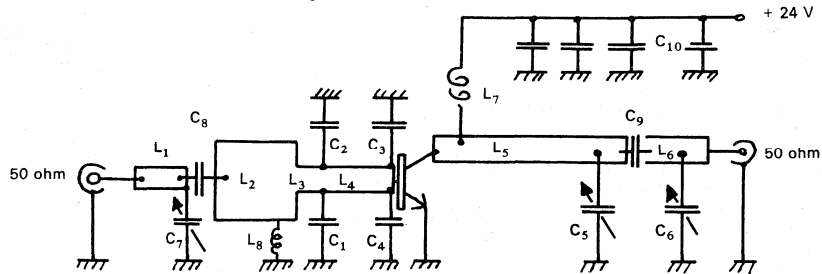
DC Current Gain ($I_C = 500$ mA, $V_{CE} = 20$ V)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 24$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	20	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Out ($V_{CE} = 24$ V, $P_{in} = 3$ W, $f = 400$ MHz)	P_{out}	25	—	—	W
Collector Efficiency ($V_{CE} = 24$ V, $P_{out} = 25$ W, $f = 400$ MHz)	η_c	60	70	—	%

$F_0 = 400 \text{ MHz}$ 

- L1 — 50 ohm line
 L2 — 22 ohm line 3% λ_g at 400 MHz
 L3 — 30 ohm line 0.5% λ_g at 400 MHz
 L4 — 30 ohm line 1% λ_g at 400 MHz
 L5 — 50 ohm line 5.5% λ_g at 400 MHz
 L6 — 50 ohm line 3.5% λ_g at 400 MHz
 L7 — 2 turns — ID 7 mm — wire 1 mm
 L8 — 0.68 μH — Molded — RFC
 C1, C2 — 18 pF — ATC — 100 A
 C3, C4 — 10 pF — ATC — 100 A
 C5 — AT 5501 — 1–20 pF — Tekelec
 C6, C7 — AT 5601 — 1–30 pF — Tekelec
 C8, C9 — 1 nF
 C10 — 1 nF + 10 nF + 0.1 μF + 10 μF Decoupling

Figure 1. Test Circuit

POLAR S-PARAMETERS 50 OHM SYSTEM								
FREQ. MHz	S 11		S 21		S 12		S 22	
	Magn	Angl°	Magn	Angl°	Magn	Angl°	Magn	Angl
100	0.957	181	3.89	99	0.019	35	0.707	190
200	0.957	178	1.97	95	0.019	45	0.724	186
300	0.957	176	1.29	75	0.025	45	0.741	184
400	0.957	174	1.06	68	0.032	50	0.749	184
500	0.957	172	0.86	63	0.035	57	0.746	183

 $V_{CE} = 25 \text{ V}$ $I_C = 850 \text{ mA}$

The RF Line UHF Power Transistor

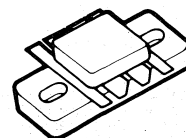
The TPM4040 is an internally matched transistor in a push-pull package specially designed for multi-octave bandwidth high gain and power applications. Its internal matching and package configuration lead to high input and output impedances.

Multi-cell die design and ultra thin beryllium oxide header allow optimum heat dissipation and operating efficiency. Long term reliability and ruggedness are guaranteed by use of diffused silicon ballast resistors and gold metallization.

- 30–400 MHz
- 40 W — P_{out}
- 28 V — V_{CC}
- Gold Metallization for Reliability
- Push-Pull Transistor
- Diffused Emitter Ballast Resistors for Ruggedness

TPM4040

40 W — 400 MHz
UHF POWER TRANSISTOR



MRP 7
CASE 827-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C ($T_{case} = 70^\circ\text{C}$)	P_D	65 0.5	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_{case} = 70^\circ\text{C}$)	$R_{\theta JC}$	2	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 40\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 6\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

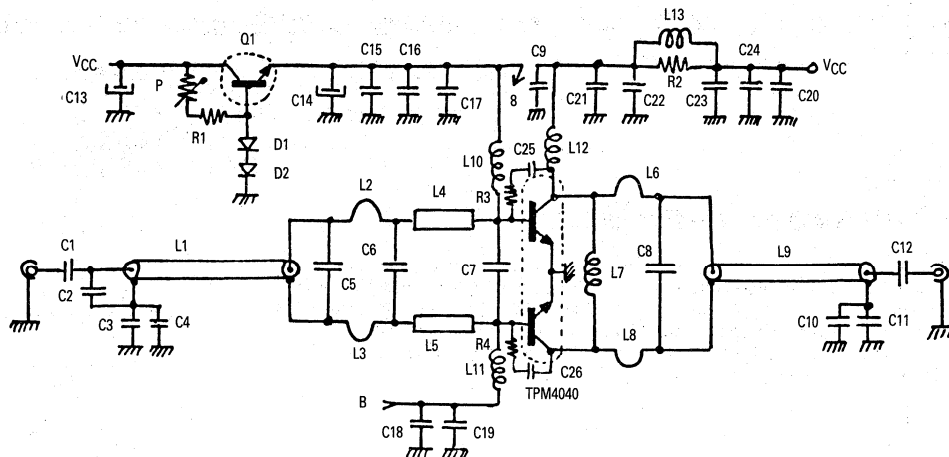
DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 20\text{ V}$)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	20	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 40\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	10	—	—	dB
Collector Efficiency ($V_{CC} = 28\text{ V}$, $P_{out} = 40\text{ W}$, $f = 400\text{ MHz}$)	η_C	50	—	—	%
Load Mismatch ($P_{out} = 40\text{ W}$, $I_{CQ} = 2 \times 50\text{ mA}$, $f = 400\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			



C1, C6, C12 — 39 pF chip capacitor
 C2 — 3.9 pF chip capacitor
 C3, C10, C15, C18, C21, C23 — 1000 pF chip capacitor
 C4, C11, C16, C19, C22, C24 — 15 nF chip capacitor
 C5 — 22 pF chip capacitor
 C7 — 68 pF chip capacitor
 C8 — 15 pF chip capacitor
 C25, C26 — 10 nF ceramic disc capacitor
 C14 — 10 μ F/5 V Electrolytic capacitor
 C13 — 100 μ F/40 V Electrolytic capacitor
 C9, C13, C17, C20 — 0.1 μ F Tantal

L1, L9 — 100 mm, 50 ohms teflon coaxial cable
 L2, L3 — hair pin L = 17 mm, 0.8 mm wire
 L4, L5 — 6 mm x 3 mm line on substrate
 L6, L8 — hair pin L = 12 mm, 0.8 mm wire
 L7 — 3 turns \varnothing 5 mm, 0.8 mm wire
 L10, L11, L12 — 15 turns \varnothing 3 mm 0.5 mm cranked wire
 L13 — 6 turns \varnothing 5 mm 1.2 mm wire

R1 — 1.2 k ohms 1/2 W
 R2 — 15 ohms 1/2 W
 R3, R4 — 1 k ohms 1/4 W

D1, D2 — 1N4007 or equivalent

Q1 — BD135 or equivalent

Substrate — teflon glass 1/50"

Figure 1. 100-400 MHz 40 W Amplifier (Class AB)

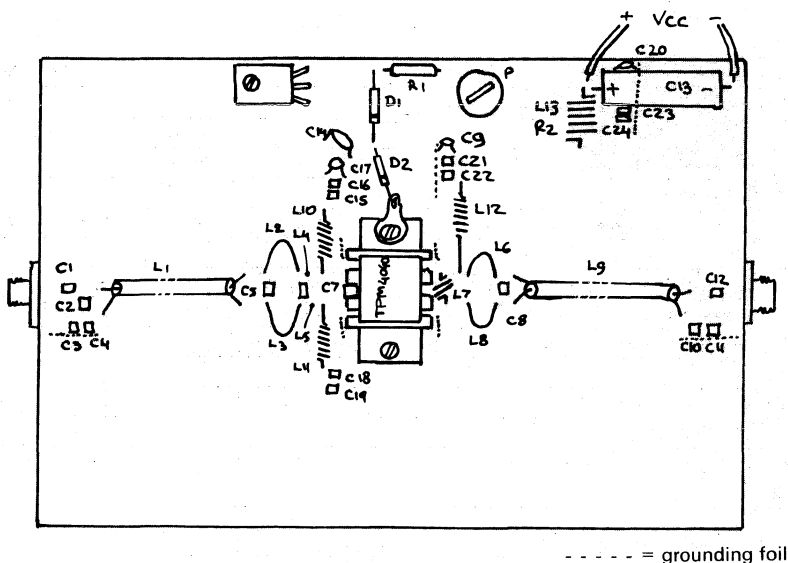
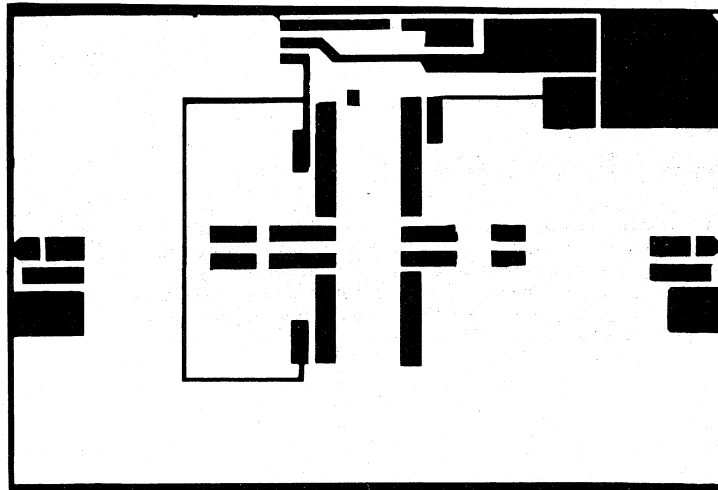


Figure 2. Components Layout



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 3. Printed circuit Board

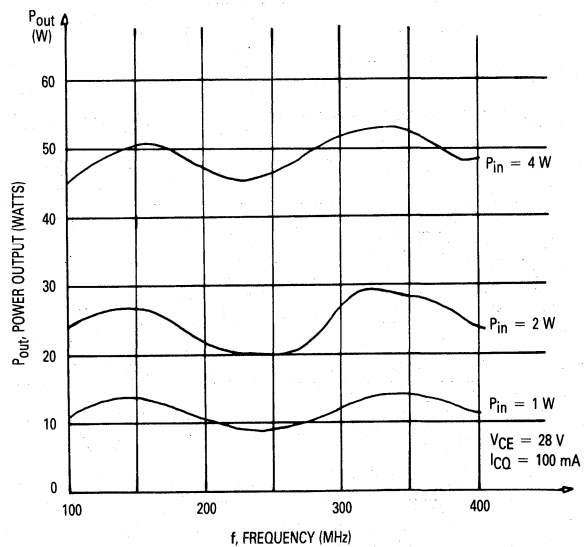


Figure 4. Typical Output Power versus Frequency

The RF Line

UHF Power Transistor

2

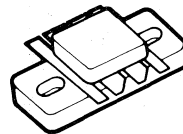
The TPM4100 is an internally matched transistor in a push-pull package specially designed for multi-octave bandwidth high power applications. Its internal matching and package configuration lead to high input and output impedances.

Multi-cell die design and ultra thin beryllium oxide header allow optimum heat dissipation and operating efficiency. Long term reliability and ruggedness are enhanced by use of diffused silicon ballast resistors and gold metallization.

- 100–400 MHz
- 100 W — P_{out}
- 28 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability

TPM4100

100 W — 400 MHz
UHF POWER TRANSISTOR



MRP 7
CASE 827-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	210 0.11	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_{case} = 60^\circ\text{C}$)	$R_{\theta JC}$	0.85	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 20\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	60	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	60	85	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 100\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	7.5	—	—	dB
Collector Efficiency ($V_{CE} = 28\text{ V}$, $P_{out} = 100\text{ W}$, $f = 400\text{ MHz}$)	η_c	50	—	—	%

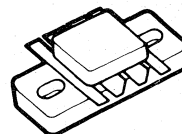
The RF Line UHF Power Transistor

... specially designed for multi-octave bandwidth high power applications. Its internal matching and package configuration lead to high input and output impedances. Multi-cell die design and ultra thin beryllium oxide header allow optimum heat dissipation and operating efficiency. Long term reliability and ruggedness are guaranteed by use of diffused silicon ballast resistors and gold metallization.

- 225–400 MHz
- 130 W — P_{out}
- 28 V — V_{CC}
- Push-Pull Transistor

TPM4130

**130 W — 400 MHz
UHF POWER TRANSISTOR**



**MRP 7
CASE 827-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	210 0.11	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	– 65 to + 200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_{case} = 60^\circ\text{C}$)	$R_{\theta JC}$	0.85	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	60	70	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 130\text{ W}$, $f = 400\text{ MHz}$)	G_{PE}	7.2	—	—	dB
Collector Efficiency ($V_{CC} = 28\text{ V}$, $P_{out} = 130\text{ W}$, $f = 400\text{ MHz}$)	η_c	60	—	—	%

TYPICAL PERFORMANCE

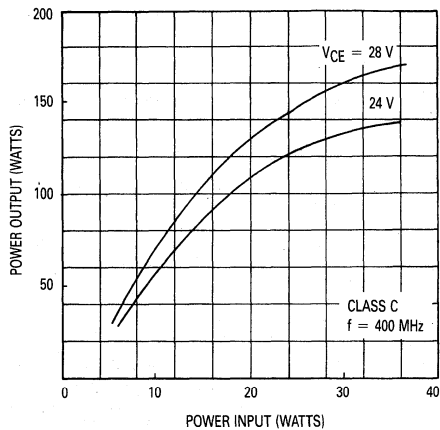


Figure 1. Power Output versus Power Input

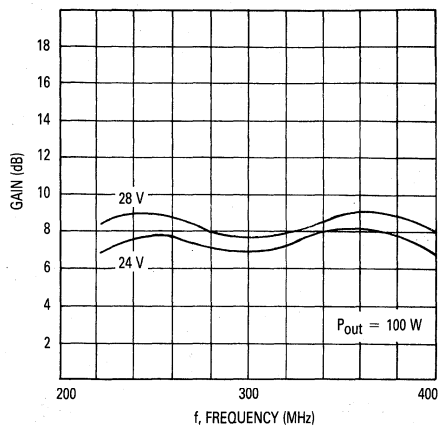


Figure 2. Gain versus Frequency

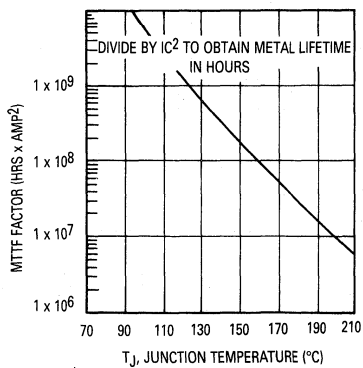


Figure 3. MTTF Factor versus T_J

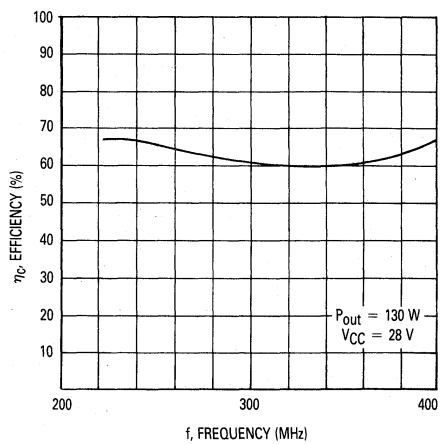
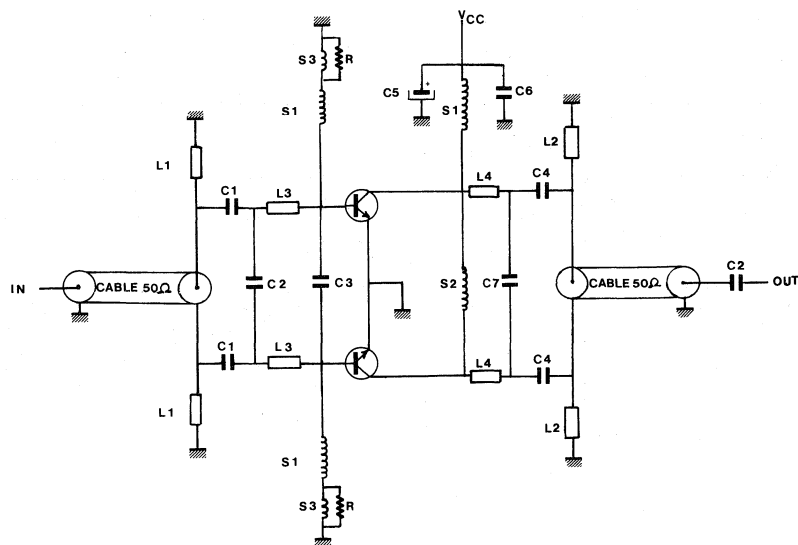


Figure 4. Efficiency versus Frequency



- L1, L4 — 30 mm 50 Ω teflon coaxial cable soldered on L2 and L12
 L2, L3 — 24 mm x 1.5 mm on substrate
 L4, L6 — 6 x 2.5 mm on substrate
 L9 — hair pin made with 24 mm of 5 mm wire (as close to the collectors as possible)
 L8 — 0.1 μ H
 L10, L11 — 8 x 1.5 mm on substrate
 L12, L13 — 30 mm x 2.5 mm on substrate

Substrate teflon-glass 1/16" ($\epsilon_r = 2.55$)

- C1 — ATC 100B 39 pF capacitors
 C2 — ATC 100B 27 pF capacitors
 C3 — ATC 100B 47 pF capacitor
 C4 — ATC 100B 33 pF capacitor
 C5 — Electrolytic capacitor 10 μ F 63 V
 C6 — Chip capacitor 100 nF
 C7 — ATC 100B 22 pF capacitor
 S1 — Inductor 0.8 mm wire 3.6 mm ID
 S2 — Inductor 0.5 mm wire 24 mm long
 S3 — Inductor 1 μ H
 R — Resistor 10 Ω $\pm 10\%$ 1/4 W
 L1 — Microstrip lines 28.5 mm x 1.5 mm
 L2 — Microstrip lines 30 mm x 2.5 mm
 L3 — Microstrip lines 11 mm x 2.5 mm
 L4 — Microstrip lines 12 mm x 2 mm

Teflon coaxial 50 Ω \varnothing 1.8 mm 27.5 mm

Figure 5. 225-400 MHz Test Circuit

The RF Line **VHF Linear** **Power Transistor**

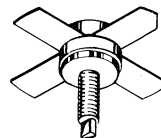
The TPV364 is a NPN gold metallized transistor using diffused ballast resistors for improved linearity. This transistor is designed for high power band III TV transposers and transmitters.

The TPV364 is used in the final stages of 20 W transposers or in the driver stages of 100 W plus transposers and transmitters.

- Band III (170–230 MHz)
- 10 W — P_{ref} @ –55 dB IMD
- 25 V — V_{CC}
- High Gain — 10 dB Min

TPV364

10 W — 230 MHz
VHF LINEAR
POWER TRANSISTOR



.380 SOE
CASE 145D-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	9	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	70 0.5	Watts W/ $^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_{case} = 70^\circ\text{C}$)	$R_{\theta JC}$	2	$^\circ\text{C/W}$
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	0.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 30\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	58	85	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Load Mismatch ($V_{CE} = 25\text{ V}$, $P_{out} = 15\text{ W}$, $f = 225\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 225\text{ MHz}$, $V_{CE} = 25\text{ V}$, $I_E = 1.6\text{ A}$, $P_{ref} = 10\text{ W}$, Vision Carrier = -8 dB Ref. , Sound Carrier = -7 dB Ref. , Sideband Signal = -16 dB Ref. , Specification TV05001)	IMD ₁	—	—	-54	dB
Intermodulation Distortion (IDEM) ($f = 225\text{ MHz}$, $V_{CE} = 25\text{ V}$, $I_E = 1.6\text{ A}$, $P_{ref} = 15\text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -10 dB , Sideband Signal = -16 dB)	IMD ₂	—	—	-52	dB
Common-Emitter Amplifier Power Gain ($V_{CE} = 25\text{ V}$, $P_{out} = 10\text{ W}$, $f = 225\text{ MHz}$, $I_E = 1.6\text{ A}$)	G _{PE}	10	—	—	dB

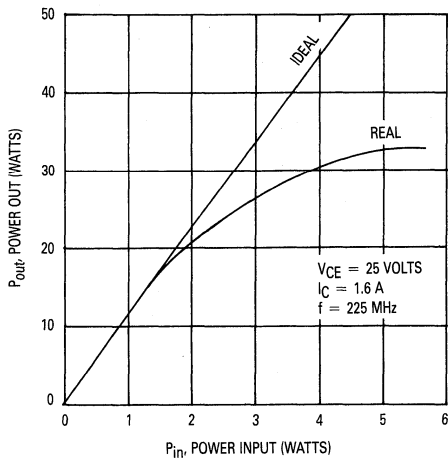


Figure 1. Power Input versus Power Output

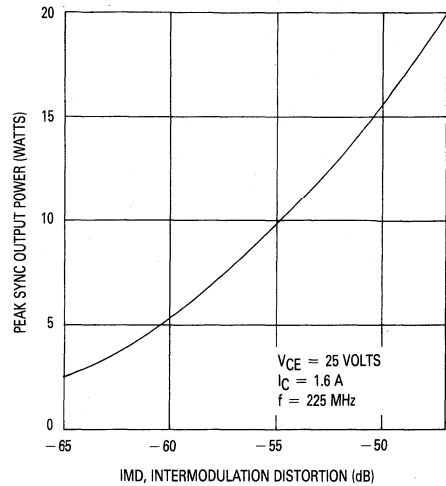


Figure 2. IMD versus Peak Sync Output Power

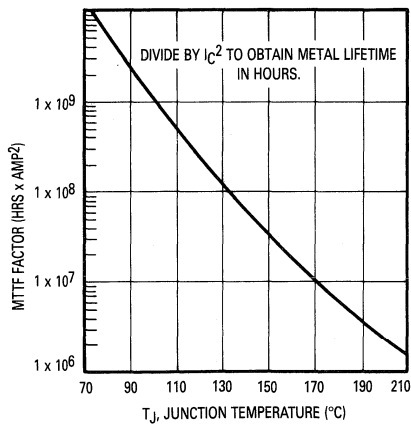


Figure 3. MTTF Factor versus T_j

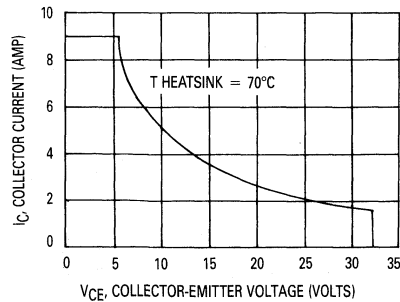


Figure 4. Safe Operating Area

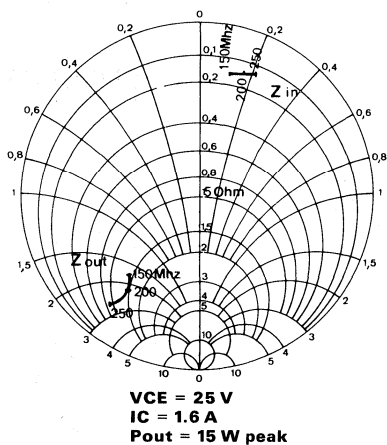


Figure 5. Large Signal Impedance versus Frequency

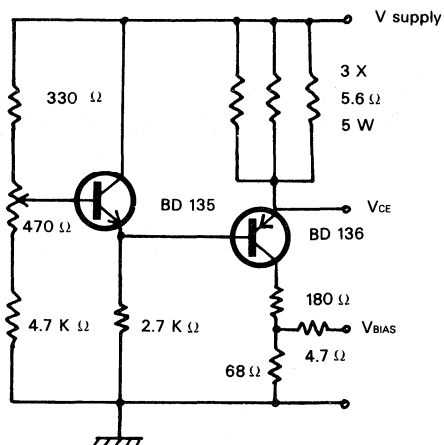
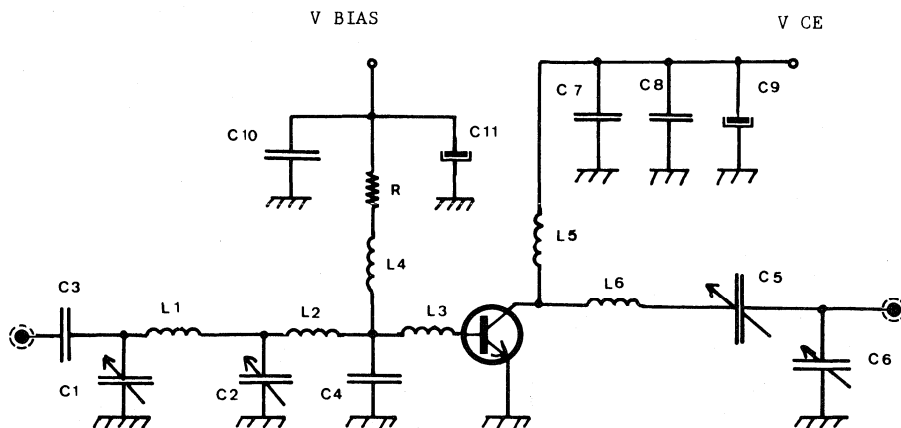


Figure 6. Bias Circuit



C1 — ARCO 403
 C2, C6 — ARCO 404
 C5 — ARCO 423
 C3, C7 — Chip capacitor 470 pF
 C4 — UNELCO-capacitor 80 pF
 C8, C10 — UNELCO-capacitor 1000 pF
 C9, C11 — 100 μ F electrolytic — 63 V

R — 4.7 ohms — 1/2 W

L1 — 1.5 turns closely wound — Cu wire 1 mm — I.D. 5 mm
 L2 — 2.5 cm — 50 ohms line
 L3 — length of the base lead
 L6 — Cu wire 1.5 mm
 L5 — 3 cm — 50 ohms line
 L4 — 5 turns closely wound — Cu wire 8 mm — I.D. 5 mm

Figure 7. 225 MHz Test Circuit

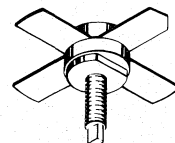
The RF Line VHF Linear Power Transistor

The TPV375 is a NPN gold metallized transistor using diffused ballast resistors for super linearity. The TPV375 is specifically designed for high power band III. TV transposers and transmitters amplifiers. Due to its high saturation power (over 70 watts), the TPV375 shows good linearity characteristics at powers over 25 W.

- Band III (170–230 MHz)
- 20 W — P_{ref} @ –51 dB IMD
- 14 W — P_{ref} @ –55 dB IMD
- 28 V — V_{CC}
- High Gain — 9 dB Typ

TPV375

**14/20 W — 170 to 230 MHz
VHF LINEAR
POWER TRANSISTOR**



**.500 SOE
CASE 145A-10, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	100 —	Watts $W/^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	1.5	$^\circ\text{C/W}$
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	0.25	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	60	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 30\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	58	85	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 20\text{ W}$, $f = 225\text{ MHz}$, $I_E = 2.5\text{ A}$)	G_{PE}	8	9	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 20\text{ W}$, $I_E = 2.5\text{ A}$, $f = 225\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 225\text{ MHz}$, $V_{CE} = 28\text{ V}$, $I_E = 2.5\text{ A}$, $P_{ref} = 14\text{ W}$, Vision Carrier = -8 dB ref. , Sound Carrier = -7 dB ref. , Sideband Signal = -16 dB ref. , Specification TV05001)	IMD_1	—	—	-55	dB
Intermodulation Distortion (IDEM) ($f = 225\text{ MHz}$, $V_{CE} = 28\text{ V}$, $I_E = 2.5\text{ A}$, $P_{ref} = 20\text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -10 dB , Sideband Carrier = -16 dB)	IMD_2	—	—	-51	dB

TYPICAL CHARACTERISTICS

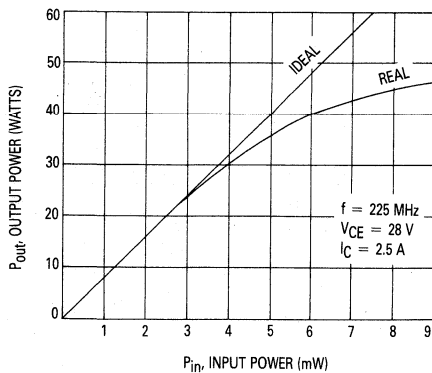


Figure 1. Power Output versus Power Input

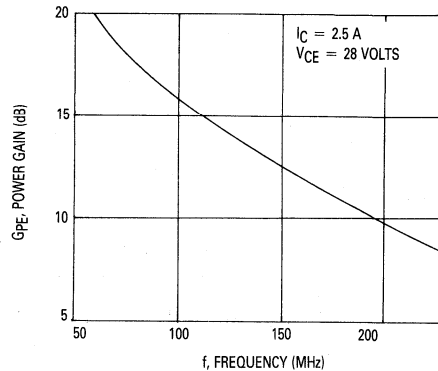


Figure 2. Power Gain versus Frequency

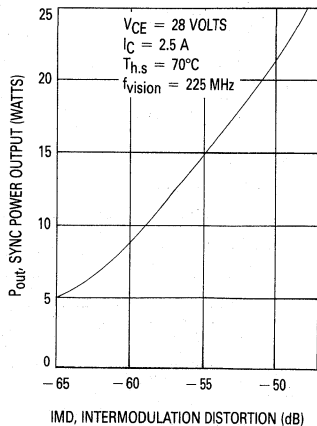


Figure 3. Intermodulation Distortion versus Peak Sync Power

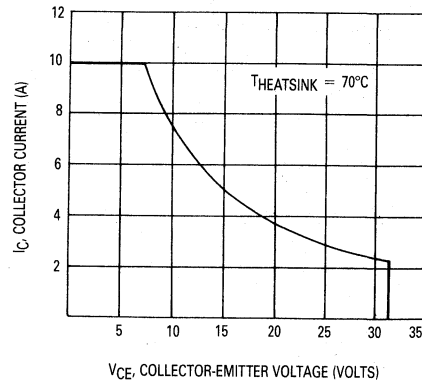


Figure 4. Safe Operating Area

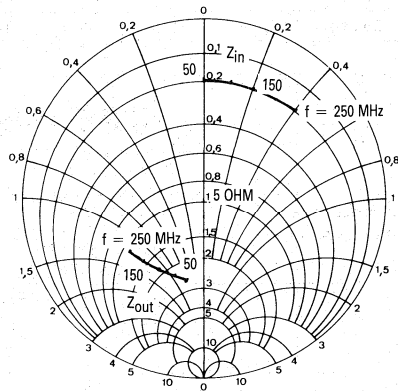


Figure 5. Large Signal Impedances versus Frequency
 $V_{CE} = 28 \text{ V} - I_C = 2.5 \text{ A}$

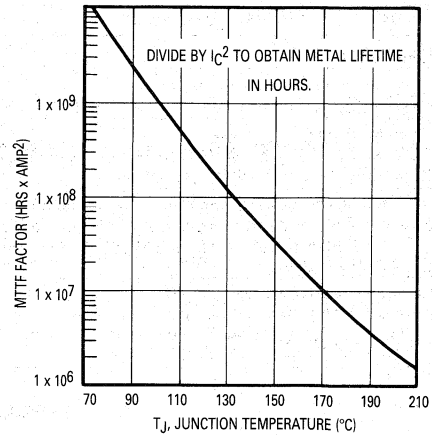
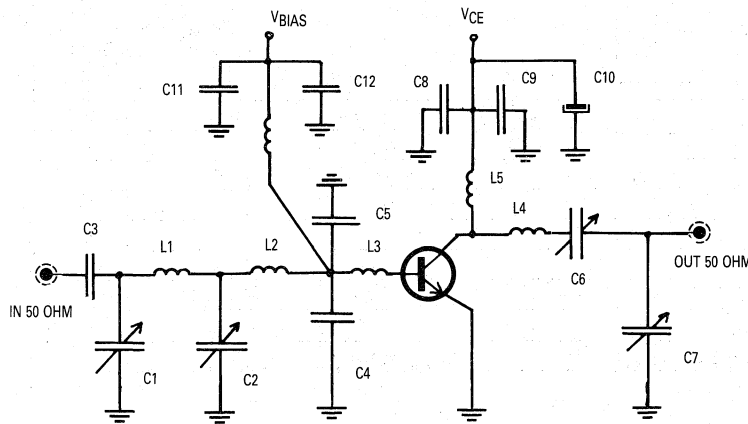


Figure 6. MTTF Factor versus T_J



C1, C7 — ARCO 403
 C2 — ARCO 404
 C3, C8 — chip capacitor 470 pF
 C4, C5 — UNELCO 80 pF
 C6 — ARCO 423
 C9, C11 — UNELCO 1000 pF
 C10 — 470 μF electrolytic
 C12 — 10 nF

L1 — 1.5 turns closely wound. Cu wire 0.7 mm I.D.
 4.5 mm

L2 — 2.1 cm — 50 ohms — line

L3 — length of the base lead

L4 — Cu wire 1.6 mm

L5 — 3.5 cm — 50 ohms line

L6 — 4 turns closely wound Cu wire 0.8 mm I.D.
 4.5 mm

Figure 7. 225 MHz Test Circuit

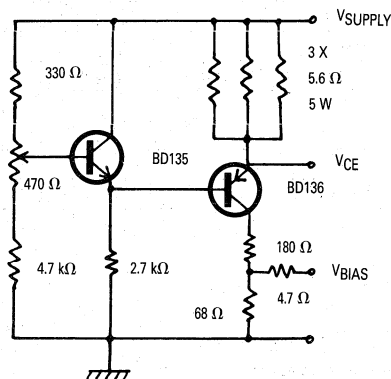


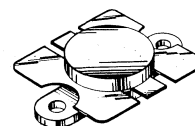
Figure 8. Bias Circuit

The RF Line

VHF Linear Power Transistor

TPV385

28 V — 170–230 MHz
VHF LINEAR
POWER TRANSISTOR



.500 J ZERO
CASE 316A-01, STYLE 1

... designed specifically for band III TV transposers and transmitter amplifiers. The TPV385 is internally matched and uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band III (170–230 MHz)
- 14 W — P_{ref} @ –53 dB IMD
- 28 V — V_{CC}
- High Gain — 14 dB Min

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	60	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	2	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 30\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	65	85	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28 \text{ V}$, $P_{out} = 14 \text{ W}$, $f = 225 \text{ MHz}$, $I_E = 2.5 \text{ A}$)	GPE	14	15	—	dB
Load Mismatch ($V_{CC} = 28 \text{ V}$, $P_{out} = 14 \text{ W}$, $I_E = 2.5 \text{ A}$, $f = 225 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 225 \text{ MHz}$, $V_{CE} = 28 \text{ V}$, $I_E = 2.5 \text{ A}$, $P_{ref} = 14 \text{ W}$, Vision Carrier = -8 dB ref. , Sound Carrier = -7 dB ref. , Sideband Signal = -16 dB ref. , Specification TV05001)	IMD ₁	—	—	-53	dB

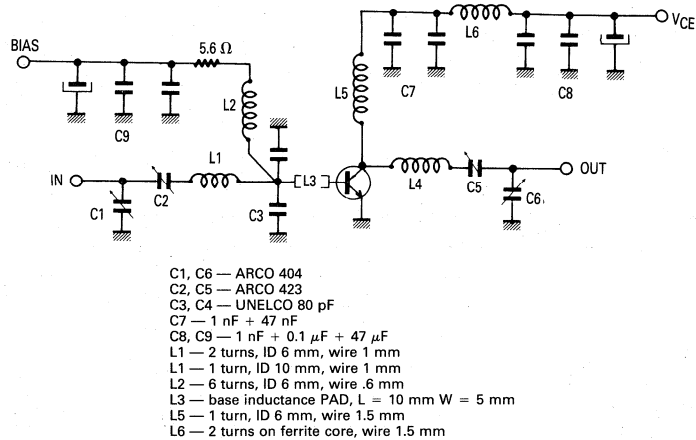


Figure 1. 225 MHz Test Circuit

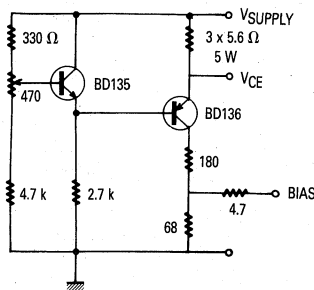


Figure 2. Bias Circuit

Advance Information

The RF Line

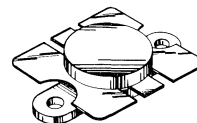
VHF Linear Power Transistor

... designed specifically for band III TV transposers and transmitter amplifiers. The TPV387 is internally matched and uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band III (170–230 MHz)
- 24 W — P_{ref} @ –50 dB IMD
- 28 V — V_{CC}
- High Gain — 13 dB Min, Class A

TPV387

28 V — 170–230 MHz
VHF LINEAR
POWER TRANSISTOR



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	1	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 20\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	60	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1\text{ A}$, $V_{CE} = 5\text{ V}$)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 30\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	130	150	pF
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(continued)

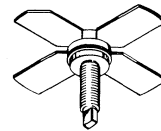
ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 28\text{ V}$, $P_{out} = 24\text{ W}$, $f = 225\text{ MHz}$, $I_E = 3.5\text{ A}$)	G_{pE}	13	—	—	dB
Load Mismatch ($V_{CC} = 28\text{ V}$, $P_{out} = 24\text{ W}$, $I_E = 3.5\text{ A}$, $f = 225\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 225\text{ MHz}$, $V_{CE} = 28\text{ V}$, $I_E = 3.5\text{ A}$, $P_{ref} = 24\text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -7 dB , Sideband Signal = -16 dB , Specification TV05001)	IMD_1	—	—	-50	dB
Output Power, 1 dB Compression Point ($V_{CE} = 28\text{ V}$, $f = 225\text{ MHz}$, $I_Q = 200\text{ mA}$)	$P_{o1\text{ dB}}$	90	—	—	W

The RF Line **VHF Linear Power Transistor**

TPV394A

**28 V — 170–230 MHz
VHF LINEAR
POWER TRANSISTOR**



**.280 SOE
CASE 244C-01, STYLE 1**

... designed specifically for band III TV transposers and transmitter amplifiers. The TPV394A is internally matched and uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band III (170–230 MHz)
- 5 W — P_{ref} @ –55 dB IMD
- 28 V — V_{CC}
- High Gain — 16 dB Typ, Class A

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 1	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	2.5	$^\circ\text{C/W}$
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	1	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 2\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20\text{ mA}$, $R_{BE} = 10\ \Omega$)	$V_{(BR)CER}$	55	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100\text{ mA}$, $V_{CE} = 5\text{ V}$)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$)	C_{ob}	—	—	35	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 5\text{ W}$, $f = 225\text{ MHz}$, $I_E = 1\text{ A}$)	G_{pE}	15	16	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 5\text{ W}$, $I_E = 1\text{ A}$, $f = 225\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 225\text{ MHz}$, $V_{CE} = 28\text{ V}$, $I_E = 1\text{ A}$, $P_{ref} = 5\text{ W}$, Vision Carrier = -8 dB ref. , Sound Carrier = -7 dB ref. , Sideband Signal = -16 dB ref. , Specification TV05001)	IMD_1	—	—	-55	dB

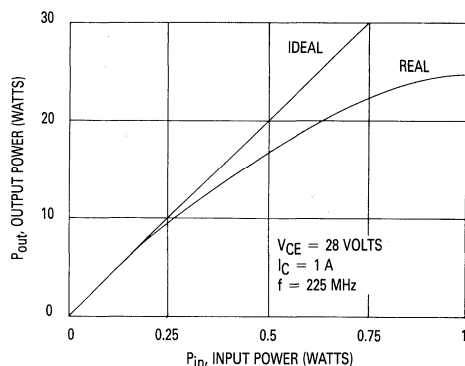


Figure 1. Output Power versus Input Power

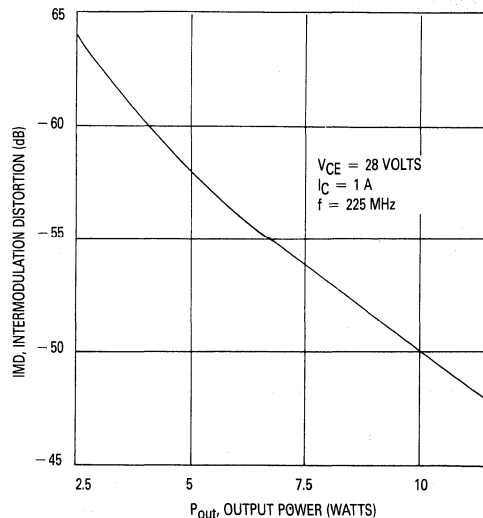


Figure 2. Intermodulation Distortion versus Output Power

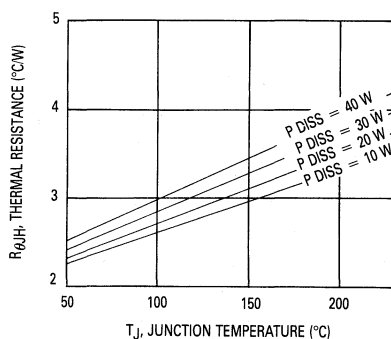


Figure 3. Thermal Resistance Junction Heatsink versus Temperature of Junction for Various Power's Dissipated

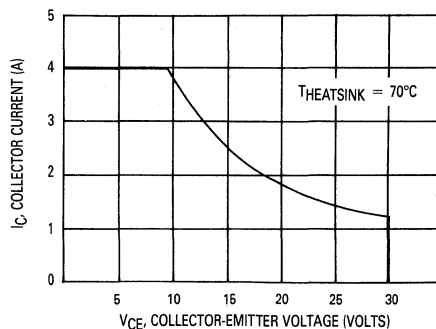


Figure 4. Safe Operating Area

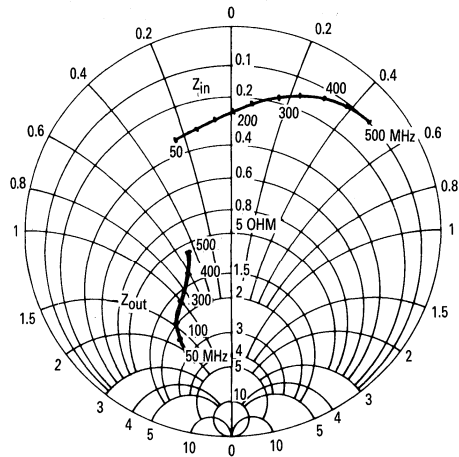


Figure 5. Large Signal Impedances versus Frequency
 $V_{CE} = 28 \text{ V} - I_C = 1 \text{ A}$

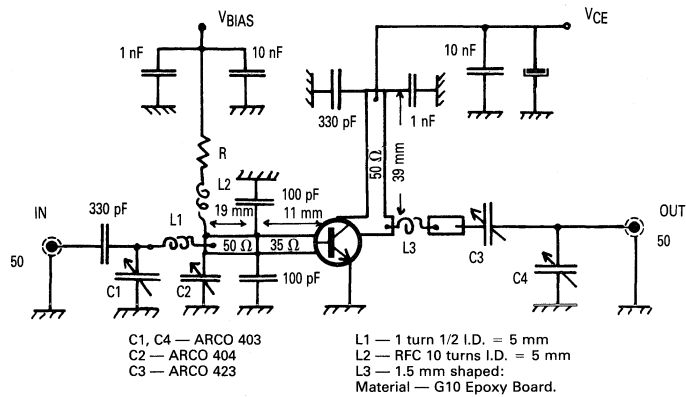


Figure 6. 225 MHz Test Circuit

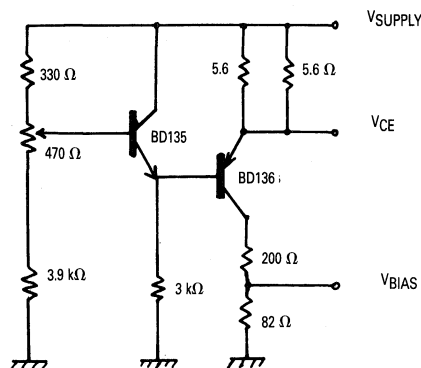


Figure 7. Class A Bias Circuit

The RF Line

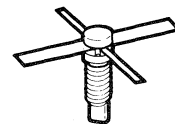
UHF Linear Power Transistor

... designed for pre-driver and driver stages in band IV and V TV transposers and transmitter amplifiers. The TPV590 uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 0.25 W — P_{ref} @ – 58 dB IMD
- 28 V — V_{CC}
- High Gain — 14 dB Min, Class A @ $f = 860$ MHz
- Gold Metallization for Reliability

TPV590

28 V — 470–860 MHz
UHF LINEAR
POWER TRANSISTOR



.200 SOE
CASE 305B-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	30	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $I_B = 0$)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.25$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $R_{BE} = 10 \Omega$)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	I_{CBO}	—	—	0.25	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 100$ mA, $V_{CE} = 5$ V)	h_{FE}	20	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	3	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 20\text{ V}$, $P_{out} = 0.25\text{ W}$, $f = 860\text{ MHz}$, $I_E = 75\text{ mA}$)	G_{PE}	14	14.5	—	dB
Load Mismatch ($V_{CC} = 20\text{ V}$, $P_{out} = 0.25\text{ W}$, $I_E = 75\text{ mA}$, $f = 860\text{ MHz}$, Load $VSWR \approx \infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 860\text{ MHz}$, $V_{CE} = 20\text{ V}$, $I_E = 75\text{ mA}$, $P_{ref} = 0.25\text{ W}$, Vision Carrier = -8 dB ref. , Sound Carrier = -7 dB ref. , Sideband Signal = -16 dB ref. , Specification TV05001)	IMD_1	—	-60	-58	dB
Cutoff Frequency ($V_{CE} = 20\text{ V}$, $I_E = 75\text{ mA}$)	f_T	3	—	—	GHz

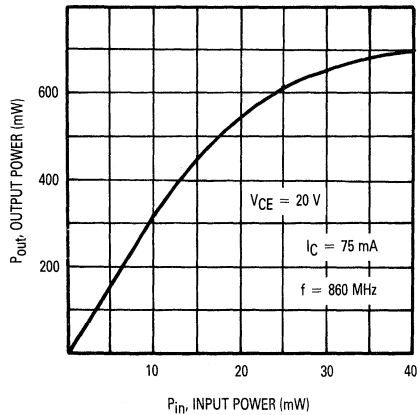


Figure 1. Output Power versus Input Power

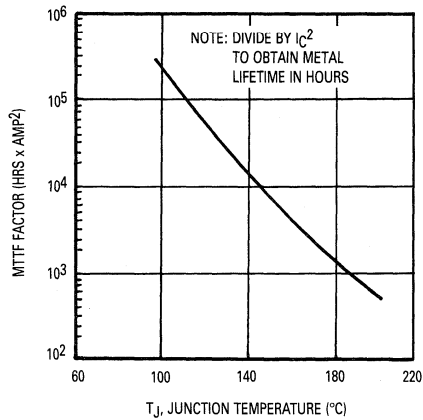


Figure 2. MTTF Factor versus Junction Temperature

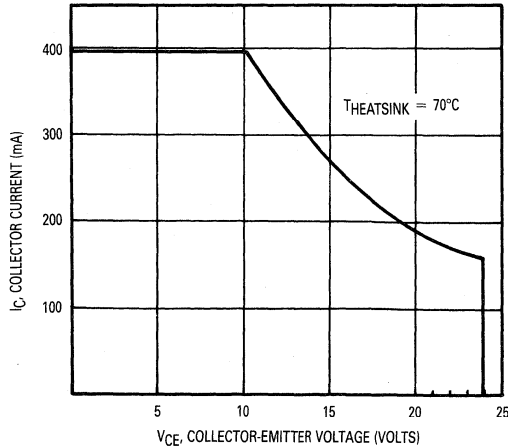


Figure 3. DC Safe Operating Area

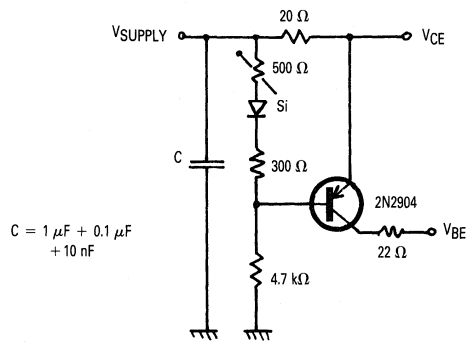


Figure 4. Bias Circuit

TPV590 S-PARAMETERS
 $V_{CE} = 20 \text{ V} - I_C = 100 \text{ mA}$

POLAR S-PARAMETERS IN 50 OHM SYSTEM								
F	S 11		S 21		S 12		S 22	
MHz	Magn	Angl°	Magn	Angl°	Magn	Angl°	Magn	Angl°
100 MHz	0.613	226°	17.78	126°	0.0199	35°	0.530	320°
200 MHz	0.732	203°	12.88	103°	0.028	33°	0.316	305°
300 MHz	0.767	192.5°	9.22	93°	0.029	33°	0.266	297°
400 MHz	0.767	185°	6.91	84°	0.033	33°	0.266	295°
500 MHz	0.754	179.5°	5.16	79°	0.033	38°	0.266	300°
600 MHz	0.776	174°	4.67	72°	0.035	42°	0.237	300°
700 MHz	0.776	170°	4.02	66°	0.039	43°	0.237	290°
800 MHz	0.767	167°	3.34	61°	0.044	44°	0.266	285°
900 MHz	0.767	163°	3.16	56°	0.047	44°	0.237	290°
1 GHz	0.776	160°	2.786	52°	0.053	45°	0.266	280°

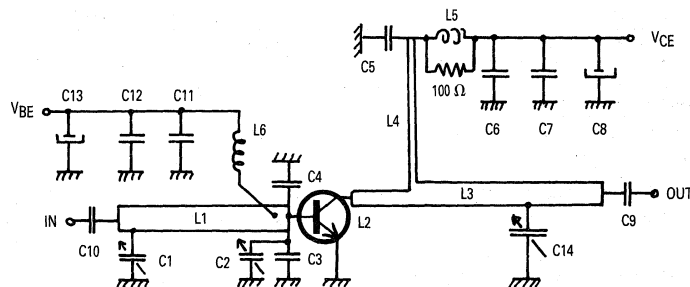


Figure 5. 860 MHz Test Circuit
 $V_{CE} = 20 \text{ V} - I_C = 75 \text{ mA}$

L1 — 50 Ω line $l = 10\%$ Ag at 860 MHz
 L2 — 100 Ω line $l = 12\%$ Ag at 860 MHz
 L3 — 50 Ω line $l = 7\%$ Ag at 860 MHz
 L4 — 120 Ω line $l = 10\%$ Ag at 860 MHz
 L5 — 6 turns ID 3 mm wire .5 mm
 L6 — 6 turns ID 3 mm wire .5 mm

C1, C2, C14 — variable AIRTRONIC C max 4.7 pF AT7275
 C3, C4 — ATC chip 10 pF
 C5 — 680 pF ATC chip
 C6, C11 — 1 nF
 C7, C12 — 10 nF
 C8 — 10 μF 63 V
 C13 — 10 μF 25 V
 C9, C10 — 1 nF chip

The RF Line

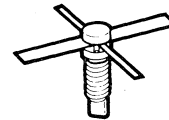
UHF Linear Power Transistor

... designed for pre-driver and driver stages in band IV and V TV transposers and transmitter amplifiers. The TPV591 uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 0.5 W — P_{ref} @ –58 dB IMD
- 28 V — V_{CC}
- High Gain — 14 dB Typ @ $f = 860$ MHz
- Gold Metallization for Reliability

TPV591

28 V — 470–860 MHz
UHF LINEAR
POWER TRANSISTOR



.200 SOE
CASE 305B-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.8	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	16	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_B = 0$)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 2$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $R_{BE} = 10 \Omega$)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	I_{CBO}	—	—	0.5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 200$ mA, $V_{CE} = 5$ V)	h_{FE}	20	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 20$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	5.5	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 20$ V, $P_{out} = 0.5$ W, $f = 860$ MHz, $I_C = 150$ mA)	G_{PE}	13	14	—	dB
Load Mismatch ($V_{CE} = 20$ V, $P_{out} = 0.5$ W, $I_C = 150$ mA, $f = 860$ MHz, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 860$ MHz, $V_{CE} = 20$ V, $I_E = 150$ mA, $P_{ref} = 0.5$ W, Vision Carrier = -8 dB, Sound Carrier = -7 dB, Sideband Signal = -16 dB, Specification TV05001)	IMD_1	—	-60	-58	dB
Cutoff Frequency ($V_{CE} = 20$ V, $I_E = 75$ mA)	f_T	3	—	—	GHz

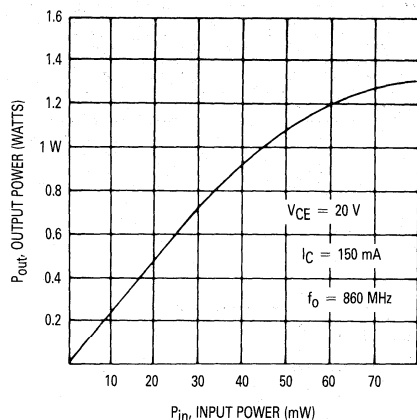


Figure 1. Output Power versus Input Power

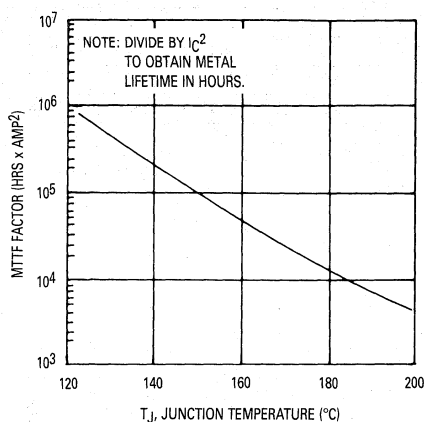


Figure 2. MTTF Factor versus Junction Temperature

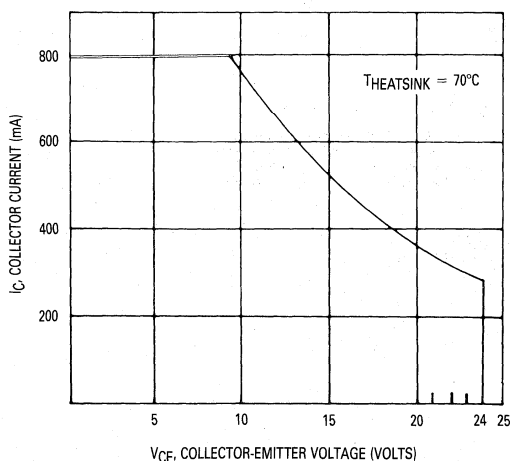


Figure 3. DC Safe Operating Area

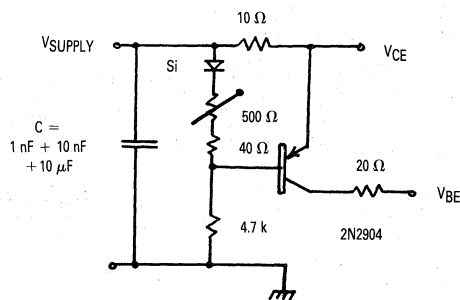
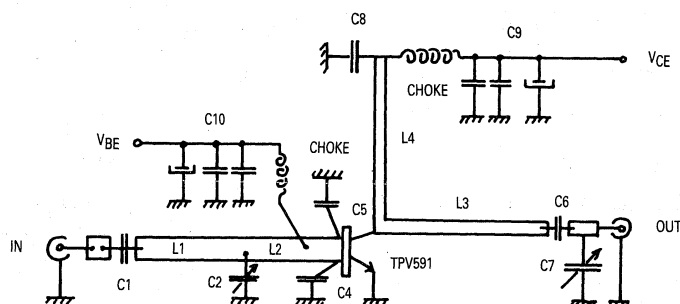


Figure 4. Bias Circuit

TPV591 S-PARAMETERS
 $V_{CE} = 20 \text{ V} - I_C = 150 \text{ mA}$

POLAR S-PARAMETERS IN 50 OHM SYSTEM								
f	S ₁₁		S ₂₁		S ₁₂		S ₂₂	
MHz	Magn	Angl°	Magn	Angl°	Magn	Angl°	Magn	Angl°
100	0.733	190	13.8	117	0.025	27	0.365	280
200	0.841	187	8.13	100	0.028	27	0.266	241
300	0.861	181	5.62	88	0.033	27	0.266	241
400	0.861	177	4.27	79	0.035	30	0.282	225
500	0.861	173	3.47	72	0.040	36	0.282	225
600	0.865	169	2.82	68	0.045	36	0.282	218
700	0.865	167	2.44	61	0.045	37	0.316	214
800	0.866	163	2.15	54	0.050	40	0.316	216
860	0.866	162	2.03	54	0.050	43	0.331	218
900	0.866	160	1.94	52	0.053	44	0.331	217
1,000	0.876	158	1.66	46	0.056	44	0.376	214



C1, C6 — 1 nF
 C2, C7 — Variable Airtronic AT7285 — max 2.5 pF
 C4 — ATC 100 A 10 pF
 C5 — ATC 100 A 6.8 pF + 4.7 pF
 C8 — 1 nF
 C9, C10 — 1 nF + 10 nF + 10 μ F

Choke: 8 turns — ID 6 mm — wire .5 mm

L1 — 50 line — $\ell = 10\%$ λ_g at 860 MHz
 L2 — 50 line — $\ell = 5\%$ λ_g at 860 MHz
 L3 — 80 line — $\ell = 13\%$ λ_g at 860 MHz
 L4 — 100 line — $\ell = 8\%$ λ_g at 860 MHz

Figure 5. 860 MHz Test Circuit
 $V_{CE} = 20 \text{ V} - I_C = 150 \text{ mA}$

Advance Information

The RF Line

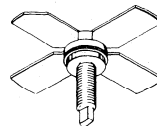
UHF Linear Power Transistor

... designed for pre-driver and driver stages in band IV and V TV transposers and transmitter amplifiers. The TPV593 uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 2 W — P_{ref} @ –60 dB IMD
- 25 V — V_{CC}
- High Gain — 9 dB Typ, Class A, $f = 860$ MHz

TPV593

25 V — 470–860 MHz
UHF LINEAR
POWER TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1.2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	11	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 80$ mA, $I_B = 0$)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 250$ mA, $V_{CE} = 20$ V)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 25$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	10	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CC} = 25$ V, $P_{out} = 2$ W, $f = 860$ MHz, $I_C = 450$ mA)	G_{PE}	8.5	9	—	dB
Intermodulation Distortion, 3 Tone ($f = 860$ MHz, $V_{CE} = 25$ V, $I_E = 450$ mA, $P_{ref} = 2$ W, Vision Carrier = –8 dB, Sound Carrier = –7 dB, Sideband Signal = –16 dB, Specification TV05001)	IMD_1	—	—	–60	dB

This document contains information on a new product. Specifications and information herein are subject to change without notice.

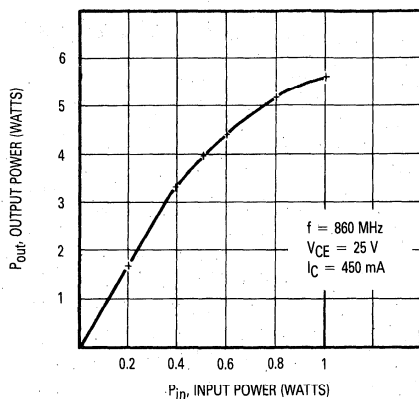


Figure 1. Output Power versus Input Power

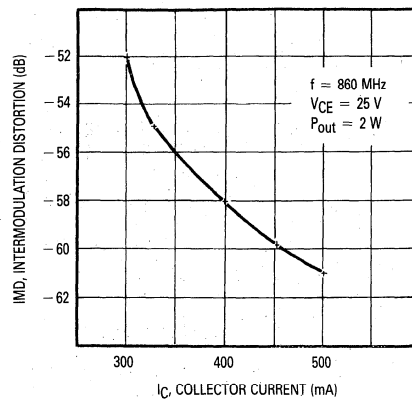


Figure 2. IMD versus Collector Current

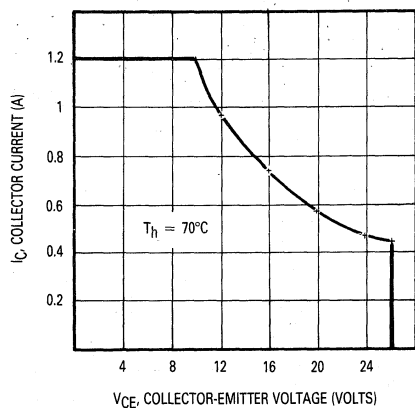


Figure 3. DC Safe Operating Area

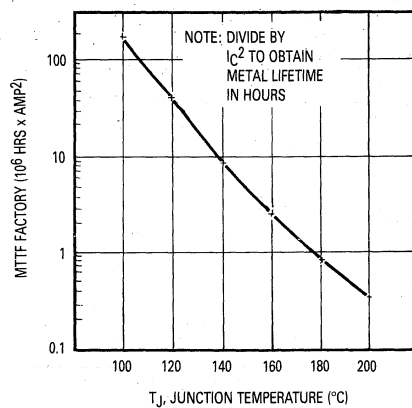


Figure 4. MTTF versus Junction Temperature

POLAR « S » PARAMETERS IN 50 OHMS SYSTEM

F	S11		S21		S12		S22		S21	K
	MAGN	ANGL	MAGN	ANGL	MAGN	ANGL	MAGN	ANGL	dB	FACTOR
470	0.93	170°	1.5	63	0.04	50°	0.55	— 166°	3.52	1.01
650	0.93	165°	1.06	50	0.05	54°	0.60	— 169°	0.51	1.04
860	0.92	162°	0.79	38	0.06	54°	0.65	— 169°	— 2	1.15

NOTE: $V_{CE} = 25 \text{ Volts}$ — $I_C = 450 \text{ mA}$ — Class A

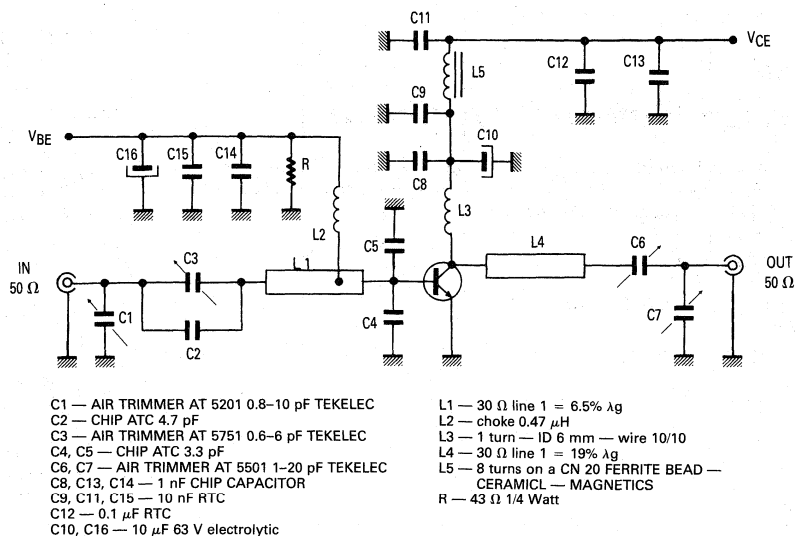


Figure 5. 860 MHz Test Circuit

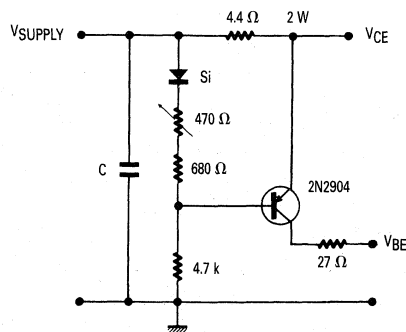


Figure 6. Bias Circuit

POLAR COORDINATES OF SIMULTANEOUS CONJUGATE MATCH IN 50 OHMS SYSTEM

F MHz	SOURCE REFL. COEFF.		LOAD REFL. COEFF.		G MAX dB
	MAGN	ANGLE	MAGN	ANGLE	
470	0.99	— 173°	0.91	124°	15.2
650	0.99	— 168°	0.83	134°	12.0
860	0.95	— 165°	0.79	146°	9.2

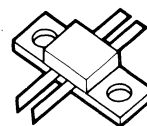
NOTE: $V_{CE} = 25$ Volts — $I_C = 450$ mA — Class A

The RF Line

UHF Linear Power Transistor

TPV595A

25 V — 470–860 MHz
UHF LINEAR
POWER TRANSISTOR



BMA2
CASE 395-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	5	Adc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	50 0.4	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-50 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	2.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 60\text{ mA}$, $I_B = 0$)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\text{ mA}$, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 3\text{ mA}$, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10\text{ mA}$, $R_{BE} = 51\ \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 20\text{ V}$, $I_E = 0$)	I_{CBO}	—	—	5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500\text{ mA}$, $V_{CE} = 20\text{ V}$)	h_{FE}	10	—	—	—
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain ($V_{CE} = 25\text{ V}$, $I_C = 2 \times 900\text{ mA}$)	G_{SSE}	8.5	—	—	dB
Load Mismatch ($V_{CC} = 25\text{ V}$, $P_{out} = 15\text{ W}$, $I_{CQ} = 2 \times 900\text{ mA}$, $f = 470\text{ MHz}$, 2 Tones, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (no degradation) ($f_0 = 470\text{ MHz}$, $V_{CE} = 25\text{ V}$, 2 Tones, $I_{CQ} = 2 \times 900\text{ mA}$)	P_{inover}	15	—	—	W
Intermodulation Distortion, 3 Tone ($f = 860\text{ MHz}$, $V_{CE} = 25\text{ V}$, $I_{CQ} = 2 \times 900\text{ mA}$, $P_{ref} = 14\text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -7 dB , Sideband Signal = -16 dB , Specification TV05001)	IMD_1	—	—	-47	dB
Intermodulation Distortion (IDEM) ($f = 860\text{ MHz}$, $V_{CE} = 25\text{ V}$, $I_{CQ} = 2 \times 900\text{ mA}$, $P_{ref} = 14\text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -10 dB , Sideband Carrier = -16 dB)	IMD_2	—	—	-50	dB

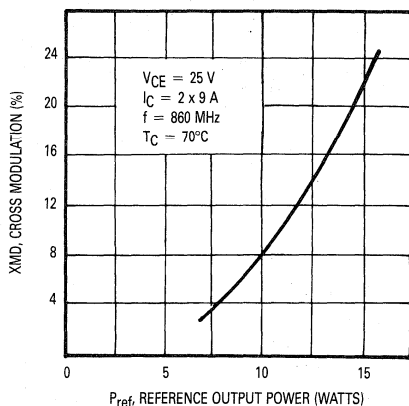


Figure 1. Cross-mod* versus Output Power

*Cross-mod: $\Delta\%$ sound (-7 dB)
— vision 0 \rightarrow PEAK

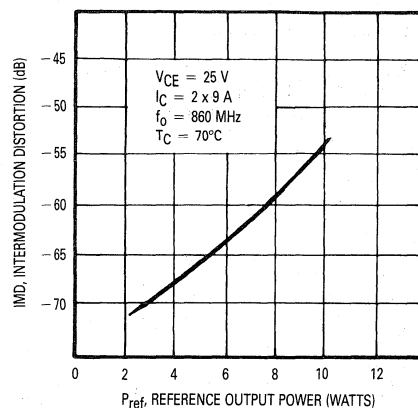


Figure 2. IMD* versus Output Power

*IMD: 3 tones -7 dB , -8 dB , -16 dB

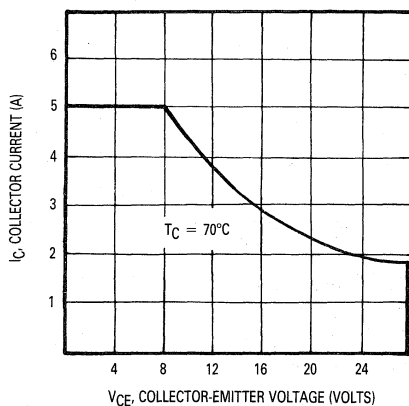


Figure 3. DC Safe Operating Area

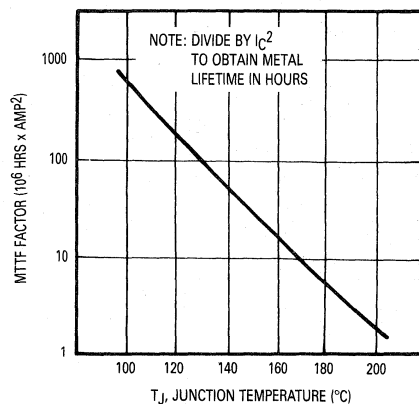


Figure 4. MTTF versus Junction Temperature

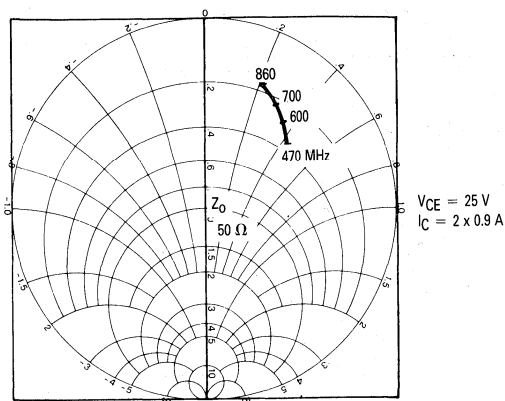


Figure 5. Z Load For Best IMD (8 W)
and Cross-Modulation (12 W)
Collector-to-Collector

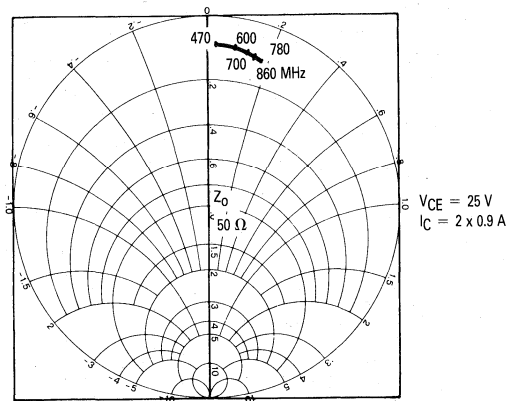
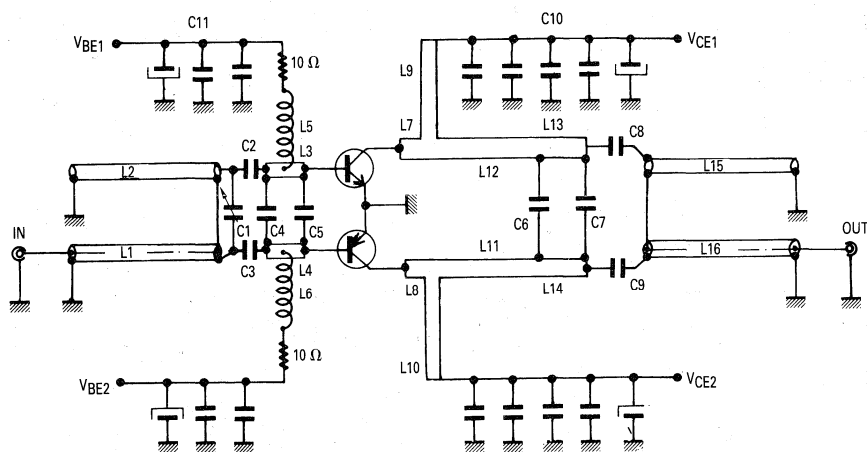


Figure 6. Z_{in} For Best Input VSWR
Base-to-Base



L1, L2, L15, L16 — 60 mm of 50 Ω — 2.2 mm semi rigid coax
L3, L4 — 50 Ω line — 5.5% λ_g at 860 MHz
L5, L6 — 3 turns ID 2 mm
L7, L8 — 50 Ω line — 1.5% λ_g at 860 MHz
L9, L10 — 50 Ω line — 4.9% λ_g at 860 MHz
L11, L12 — 50 Ω line — 2% λ_g at 860 MHz
L13, L14 — 50 Ω line — 1.5% λ_g at 860 MHz

C1 — 0.5–4.5 pF GIGATRIM TRIMMER
C2, C3 — 27 pF ATC 100 A
C4 — 6.8 pF ATC 100 A
C5 — 18 pF ATC 100 A
C6 — 3.3 pF ATC 100 A
C7 — 4.7 pF ATC 100 A
C8, C9 — 27 pF ATC 100 A
C10 — + 330 pF ATC 100 B
+ 1 nF + 10 nF + 47 μ F
C11 — 1 nF + 10 nF + 10 μ F

Figure 7. 470–860 MHz Broadband Amplifier

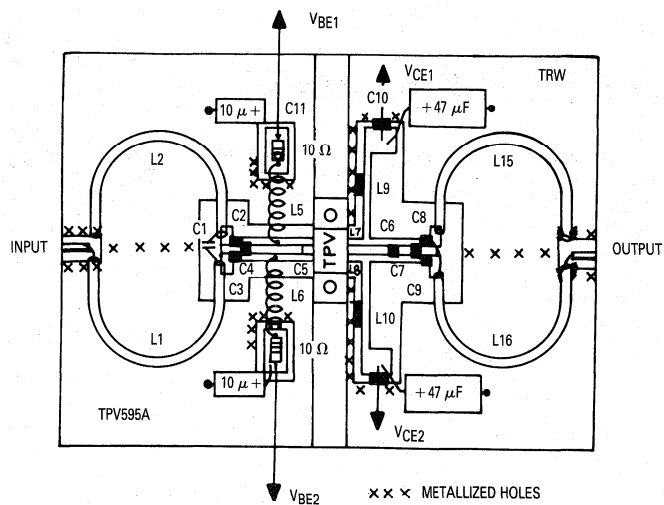


Figure 8. 470-860 MHz Broadband Amplifier

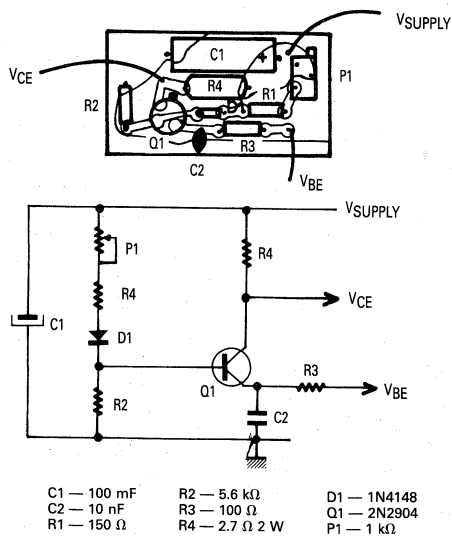


Figure 9. Bias Circuit

The RF Line

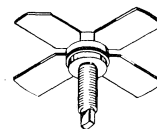
UHF Linear Power Transistor

TPV596A

... designed for very high output 1.5 V MATV amplifiers up to 860 MHz and 500 mW Band V TV transposer stages. Gold metallization and diffused emitter ballast resistors are used to enhanced reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 0.5 W — P_{ref} @ –58 dB IMD
- High Gain — 12 dB Typ, Class A @ $f = 860$ MHz
- Gold Metallization for Reliability

0.5 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.7	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	8.75 0.05	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	20	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_B = 0$)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.25$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	I_{CBO}	—	—	0.45	mA _{dc}
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $R_{BE} = 10$ Ω)	$V_{(BR)CER}$	50	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	15	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	5	pF
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(continued)

TPV596A

FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 20 \text{ V}$, $P_{out} = 0.5 \text{ W}$, $f = 860 \text{ MHz}$, $I_E = 0.22 \text{ A}$)	GPE	11.5	12	—	dB
Load Mismatch ($V_{CE} = 20 \text{ V}$, $P_{out} = 1 \text{ W}$, $I_E = 0.22 \text{ A}$, $f = 860 \text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 860 \text{ MHz}$, $V_{CE} = 20 \text{ V}$, $I_E = 0.22 \text{ A}$, $P_{ref} = 1 \text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -7 dB , Sideband Signal = -16 dB , Specification TV05001)	IMD ₁	—	—	-50	dB
Intermodulation Distortion (IDEM) ($f = 860 \text{ MHz}$, $V_{CE} = 20 \text{ V}$, $I_E = 0.22 \text{ A}$, $P_{ref} = 0.5 \text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -10 dB , Sideband Carrier = -16 dB)	IMD ₂	—	-60	-58	dB

TYPICAL CHARACTERISTICS

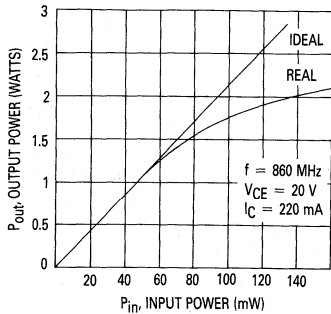


Figure 1. Power Output versus Power Input

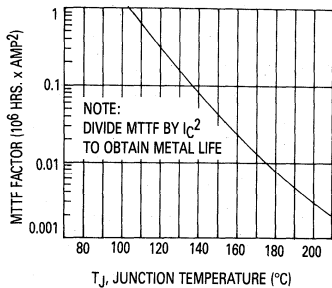


Figure 3. MTTF Factor versus Junction Temperature

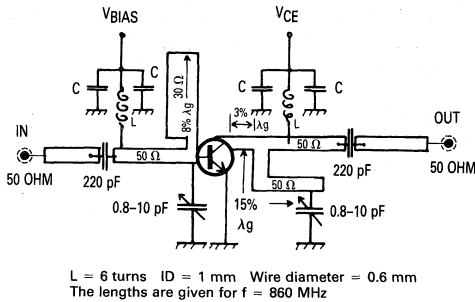


Figure 5. 860 MHz Test Circuit

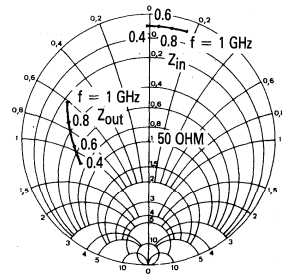


Figure 2. Large Signal Impedances
 $V_{CE} = 20 \text{ V}$ — $I_C = 220 \text{ mA}$

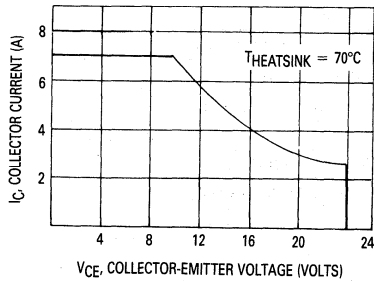


Figure 4. DC Safe Operating Area

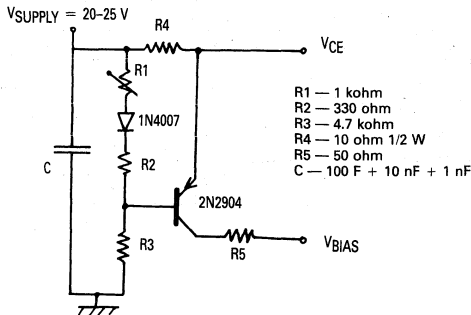


Figure 6. Class A Bias Circuit

TPV597

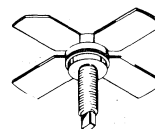
The RF Line

UHF Linear Power Transistor

... designed for 1 watt stages in Band V TV transposer amplifiers. Gold metallized dice and diffused emitter ballast resistors are used to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 1 W — P_{ref} @ –58 dB IMD
- 20 V — V_{CC}
- High Gain — 11 dB Typ, Class A @ $f = 860$ MHz
- Gold Metallization for Reliability

1 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	1.4	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	19 0.11	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–65 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	9	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 40$ mA, $I_B = 0$)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 2$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 40$ mA, $R_{BE} = 10$ Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 28$ V, $I_E = 0$)	I_{CBO}	—	—	0.45	mA

ON CHARACTERISTICS

DC Current Gain ($I_C = 200$ mA, $V_{CE} = 5$ V)	h_{FE}	15	—	120	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	7	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 20\text{ V}$, $P_{out} = 1\text{ W}$, $f = 860\text{ MHz}$, $I_E = 0.44\text{ A}$)	G_{PE}	10.5	11	—	dB
Load Mismatch ($V_{CE} = 20\text{ V}$, $P_{out} = 2\text{ W}$, $I_E = 0.44\text{ A}$, $f = 860\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 860\text{ MHz}$, $V_{CE} = 20\text{ V}$, $I_E = 0.44\text{ A}$, $P_{ref} = 1\text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -7 dB , Sideband Signal = -16 dB , Specification TV05001)	IMD_1	—	-60	-58	dB
Cutoff Frequency ($V_{CE} = 20\text{ V}$, $I_E = 0.44\text{ A}$)	f_r	2.2	2.5	—	GHz
Intermodulation Distortion (IDEM) ($f = 860\text{ MHz}$, $V_{CE} = 20\text{ V}$, $I_E = 0.44\text{ A}$, $P_{ref} = 2\text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -10 dB , Sideband Signal = -16 dB)	IMD_2	—	—	-51	dB

TYPICAL CHARACTERISTICS

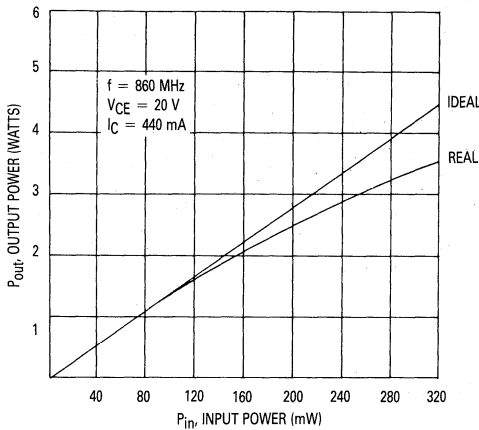


Figure 1. Power Output versus Power Input

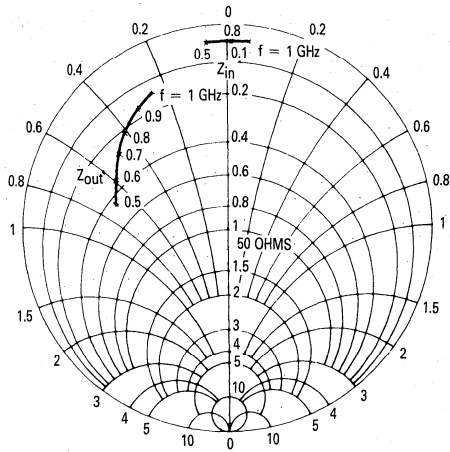


Figure 2. Large Signal Impedances
 $V_{CE} = 20\text{ V} - I_C = 440\text{ mA}$

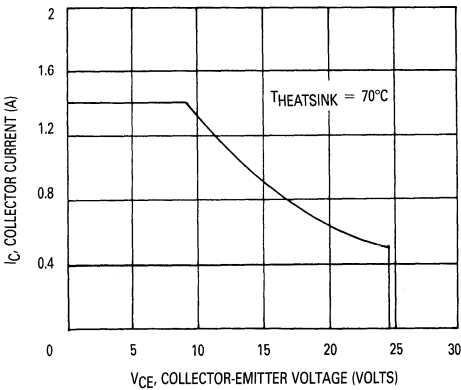


Figure 3. Safe Operating Area

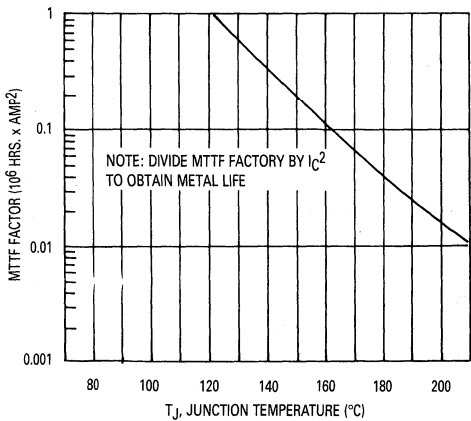
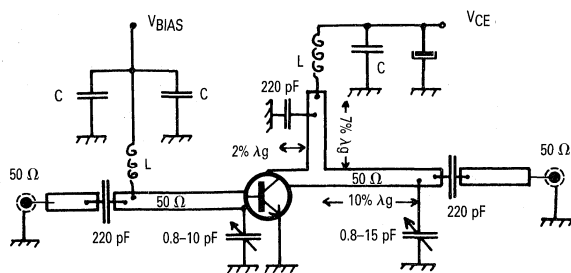


Figure 4. MTTF Factor versus Junction Temperature



$L = 6$ turns $ID = 1$ mm Wire diameter = 0.6 mm
The lengths are given for $f = 860$ MHz

Figure 5. 860 MHz Test Circuit

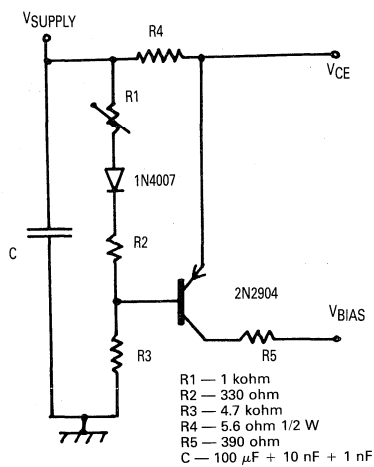


Figure 6. Class A Bias Circuit

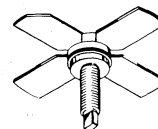
TPV598

Advance Information
The RF Line
UHF Linear Power Transistor

4 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR

... designed for 4 watt stages in Band V TV transposer amplifiers. Gold metallized dice and diffused emitter ballast resistors are used to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 4 W — P_{ref} @ –60 dB IMD
- 25 V — V_{CC}
- High Gain — 7 dB Min, Class A @ $f = 860$ MHz
- Gold Metallization for Reliability



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	27	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	6.2	°C/W
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	0.4 Typ	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_B = 0$)	$V_{(BR)CEO}$	27	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500$ mA, $V_{CE} = 20$ V)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 25$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	20	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 25$ V, $P_{out} = 4$ W, $f = 860$ MHz, $I_C = 850$ mA)	G_{PE}	7	—	—	dB
Intermodulation Distortion, 3 Tone ($f = 860$ MHz, $V_{CE} = 25$ V, $I_E = 850$ mA, $P_{ref} = 4$ W, Vision Carrier = –8 dB, Sound Carrier = –7 dB, Sideband Signal = –16 dB, Specification TV05001)	IMD_1	—	—	–60	dB
Cutoff Frequency ($V_{CE} = 25$ V, $I_C = 850$ mA)	f_r	—	2	—	GHz

This document contains information on a new product. Specifications and information herein are subject to change without notice.

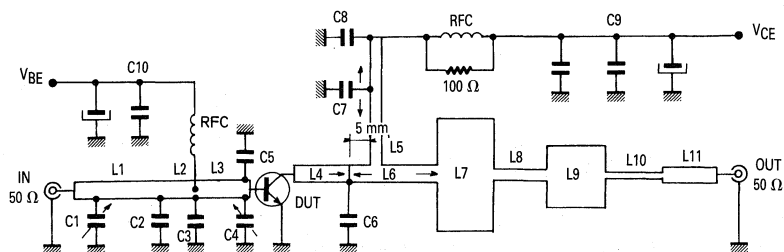


Figure 1. Broadband Test Circuit

C1 — VARIABLE 0.5–4.7 pF AIRTRONIC
 C2, C3 — ATC 4.7 pF
 C4 — ATC 10 pF + VARIABLE 0.5–4.7 pF AIRTRONIC
 C5 — ATC 10 pF + ATC 5.6 pF
 C6 — ATC 18 pF + 0.5–4.7 pF VARIABLE AIRTRONIC
 C7 — 470 pF CHIP CAPACITOR
 C8 — 1 nF + 10 nF DECOUPLING
 C9 — 1 nF + 10 nF + 0.1 μ F + 10 μ F
 C10 — 10 nF + 1 μ F + 10 μ F

RFC = 8 turns ID 2.5 mm Wire = 0.5 mm

L1 — 50 Ω line 6.2% Ag at 860 MHz
 L2 — 50 Ω line 4.2% Ag at 760 MHz
 L3 — 50 Ω line 4.9% Ag at 860 MHz
 L4 — 20 Ω line 6.5% Ag at 860 MHz
 L5 — 50 Ω line 5 % Ag at 860 MHz
 L6 — 20 Ω line 9.5% Ag at 860 MHz
 L7 — 4 Ω line 8 % Ag at 860 MHz
 L8 — 55 Ω line 7.5% Ag at 860 MHz
 L9 — 7.5 Ω line 8 % Ag at 860 MHz
 L10 — 100 Ω line 8 % Ag at 860 MHz
 L11 — 20 Ω line 8 % Ag at 860 MHz

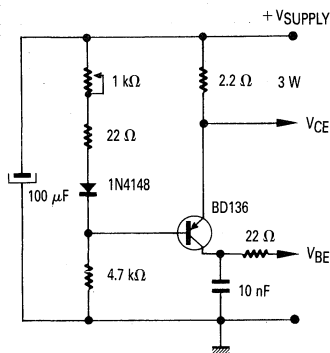


Figure 2. Class A Bias Circuit

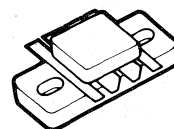
The RF Line
UHF Linear Power Transistor

... designed for high power stages in Band V TV transposer amplifiers. Gold metallized dice and diffused emitter ballast resistors are used to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 6 W — P_{ref} @ –58 dB IMD
- 25 V — V_{CC}
- High Gain — 9 dB Typ, Class A @ $f = 860$ MHz
- Push-Pull Package

TPV657

6 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR



MRP-17
827-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	27	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 70^\circ\text{C}$ Derate above 70°C	P_D	50 —	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–25 to +200	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	2.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_E = 0$)	$V_{(BR)CEO}$	27	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $R_{BE} = 51 \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 20$ V, $I_E = 0$)	I_{CBO}	—	—	5	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 500$ mA, $V_{CE} = 10$ V)	h_{FE}	20	—	100	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 25$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	18	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain ($V_{CE} = 25\text{ V}$, $P_{out} = 6\text{ W}$, $f = 860\text{ MHz}$, $I_C = 1.7\text{ A}$)	GSS	8	9	—	dB
Intermodulation Distortion, 3 Tone ($f = 860\text{ MHz}$, $V_{CE} = 25\text{ V}$, $I_E = 1.7\text{ A}$, $P_{ref} = 6\text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -7 dB , Sideband Signal = -16 dB , Specification TV05001)	IMD ₁	—	-60	-58	dB

TYPICAL CHARACTERISTICS

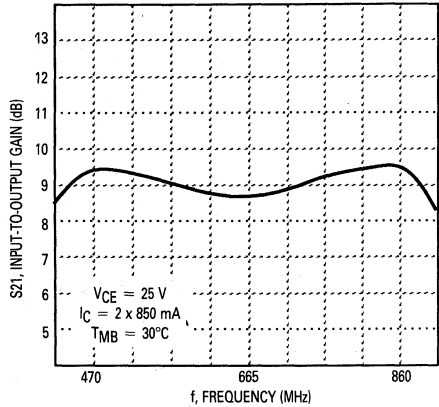


Figure 1. S21 Parameter versus Frequency

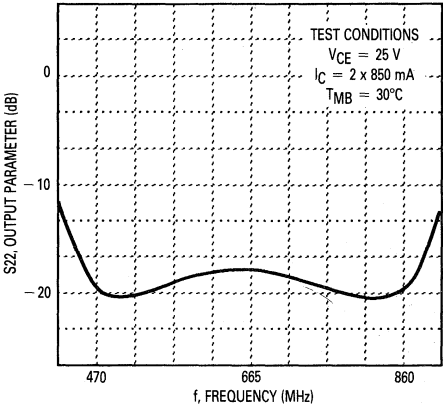


Figure 2. S22 Parameter versus Frequency

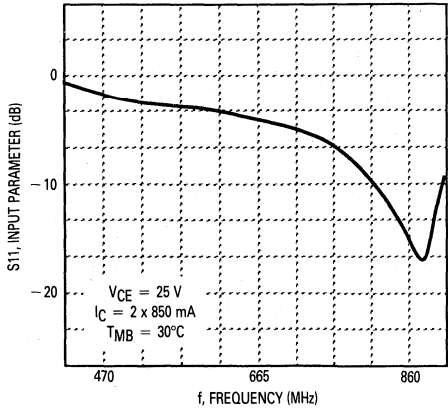


Figure 3. S11 Parameter versus Frequency

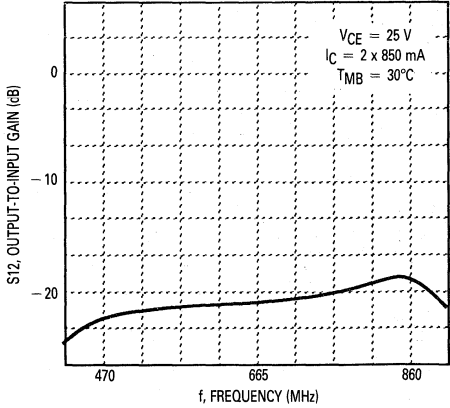
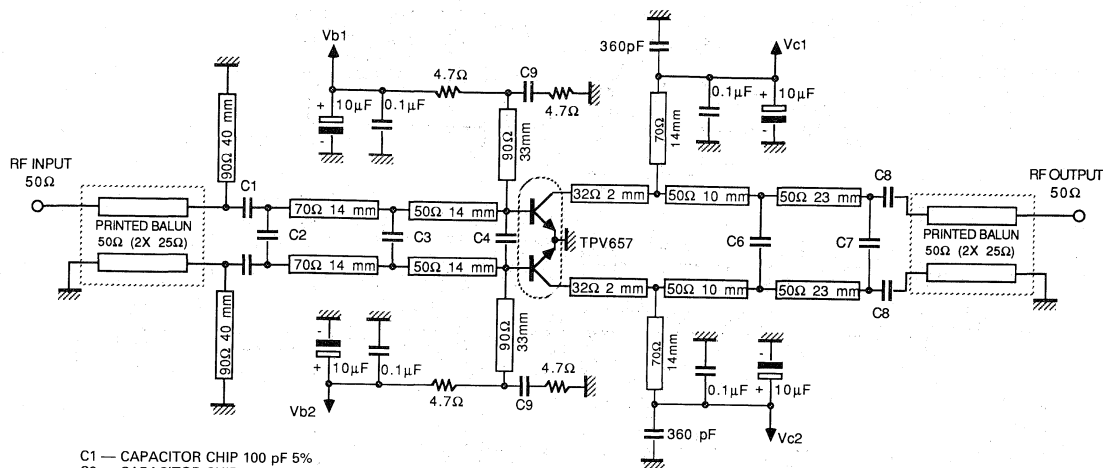


Figure 4. S12 Parameter versus Frequency

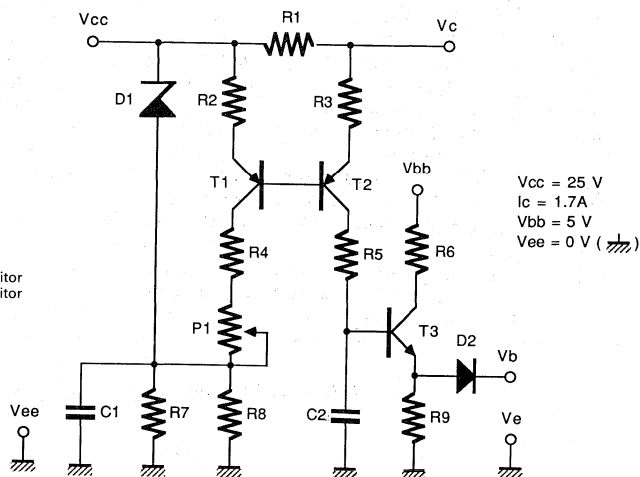


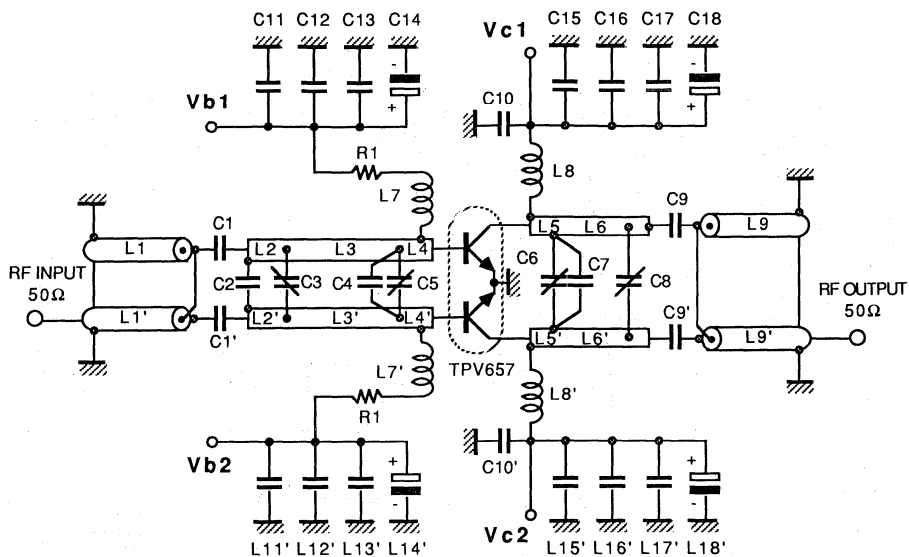
- C1 — CAPACITOR CHIP 100 pF 5%
 C2 — CAPACITOR CHIP 3.3 pF 5%
 C3 — CAPACITOR AJUST 0.1–4 pF
 + CAPACITOR CHIP 1 pF
 C4 — CAPACITOR CHIP 10 pF
 + CAPACITOR AJUST 0.1–4 pF
 C5 — CAPACITOR CHIP 180 pF
 C6 — CAPACITOR CHIP 4.7 pF
 + CAPACITOR AJUST 0.1–4 pF
 C7 — CAPACITOR CHIP 1 pF
 C8 — CAPACITOR CHIP 47 pF

Figure 5. Wideband Amplifier

CLASS A CONDITIONS (25 V — 2 x 850 mA)
 470 / 860 MHz
 9 dB GAIN
 -60 dB IMD @ 6 W ref (-8 dB/-16 dB/-7 dB)

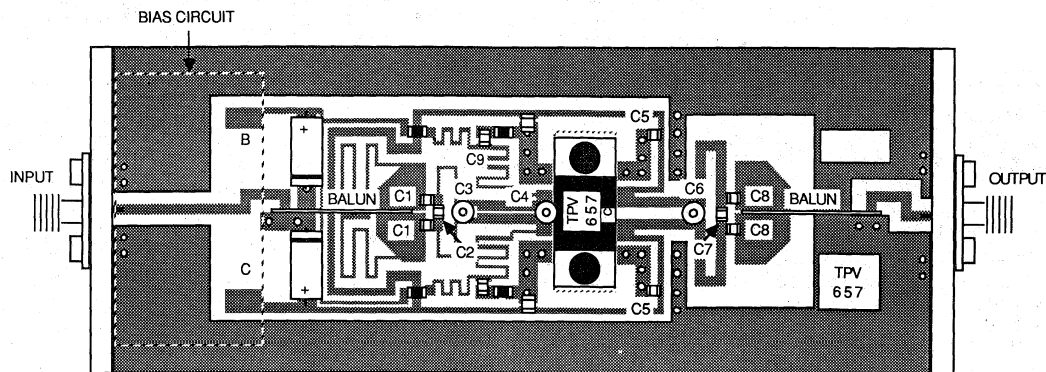
- R1b — 0.1 Ω 1 W
 R2 — 270 Ω 1/4 W
 R3 — 4.7 Ω 1/4 W
 R4 — 6.8 Ω 1/4 W
 R5 — 330 Ω 1/4 W
 R6 — 15 Ω 1/4 W
 R7 — 2.2 kΩ 1/4 W
 R8 — 2.2 kΩ 1/4 W
 R9 — 1 kΩ 1/4 W
 P1 — 5 kΩ 10 turns
 C1 — 1 nF ceramic capacitor
 C2 — 1 nF ceramic capacitor
 D1 — Zener Diode 4.7 V
 T1, T2 — BC557
 T3 — 2N2219

Figure 6. Class A Biasing Circuit
(one for each side of the push-pull transistor)



COMPONENTS LIST			
REF. MARK	DESCRIPTION	REFERENCY	SUPPLIER
C1-C9	CAPACITOR CHIP 82 PF 5%	100A820JP50	ATC
C2-C4-C7	CAPACITOR CHIP 4.7 PF 5%	100A4R7DP50	ATC
C3-C5-C6-C8	CAPACITOR AJUST. 1-4PF	GKU 4R0	PYRECAP
C11-C15	CAPACITOR CHIP 1nF	0805	SPRAGUE
C12-C16	CAPACITOR CHIP 0.1μF	VJ0907Y104MH	VITRAMON
C10	CAPACITOR CHIP 100PF 5%	100A101JP50	ATC
C13-C17	CAPACITOR CHIP 15nF	0805	SPRAGUE
C14-C18	CAPACITOR 10μF 40V	CC31	SICSAFCO
R1+L7	10Ω 1/4 W	SFR 25	RTC
L1-L9	50Ω COAXIAL CABLE 29MM	AE50070	SEAELECTRO
L2	52Ω STRIPLINE L=3MM	PRINTED LINE	-
L3	52Ω STRIPLINE L=12MM	PRINTED LINE	-
L4	39Ω STRIPLINE L=8MM	PRINTED LINE	-
L5	39Ω STRIPLINE L=14MM	PRINTED LINE	-
L6	39Ω STRIPLINE L=18MM	PRINTED LINE	-
L8	1 TURN WIRE ID : 4 MM	WIRE Ø 1MM	-

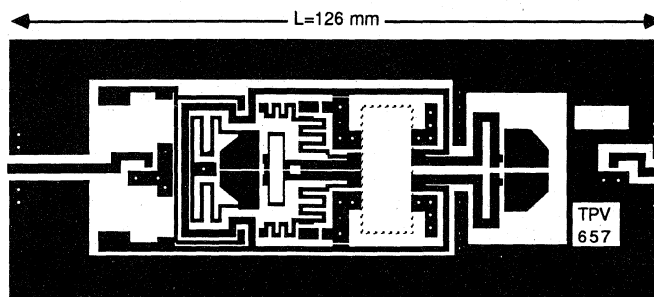
Figure 7. 860 MHz Test Circuit



BIAS Circuit Connection:

Vee (Ground)
Vcc (25 V)
Vbb (5 V)

Figure 8. Layout for Wideband Amplifier



(Not to Scale)

Figure 9. Test Circuit

TPV693

Advance Information

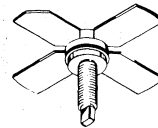
The RF Line

UHF Linear Power Transistor

... designed for 2 watt stages in Band V TV transposer amplifiers. Gold metallized dice and diffused emitter ballast resistors are used to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 1.8 W — P_{ref} @ –60 dB IMD
- 25 V — V_{CC}
- High Gain — 10 dB Typ, Class A @ $f = 860$ MHz

1.8 W — 470 to 860 MHz
 UHF LINEAR
 POWER TRANSISTOR



.280 SOE
 CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	8	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $I_B = 0$)	$V_{(BR)CEO}$	4	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ mA, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 250$ mA, $V_{CE} = 5$ V)	h_{FE}	20	—	90	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 25$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	9	10	pF
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FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 25$ V, $P_{out} = 1.8$ W, $f = 860$ MHz, $I_C = 500$ mA)	G_{PE}	9.5	10	—	dB
Intermodulation Distortion, 3 Tone ($f = 860$ MHz, $V_{CE} = 25$ V, $I_E = 500$ mA, $P_{ref} = 1.8$ W, Vision Carrier = –8 dB, Sound Carrier = –7 dB, Sideband Signal = –16 dB, Specification TV05001)	IMD ₁	—		–60	dB

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Advance Information

The RF Line

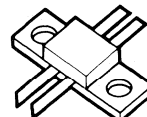
UHF Linear Power Transistor

... designed for driver and output stages in band IV and V TV transposers and transmitter amplifiers. The TPV695A uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 14 W — P_{ref} @ –47 dB IMD
- 25 V — V_{CC}
- High Gain — 10 dB Min, Class A, $f = 860$ MHz
- Gold Metallization for Reliability
- Push-Pull Package

TPV695A

25 V — 470–860 MHz
UHF LINEAR
POWER TRANSISTOR



BMA2
CASE 395-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	5	Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	50 0.4	Watts W/ $^\circ\text{C}$
Operating Junction Temperature	T_J	200	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	–50 to +200	$^\circ\text{C}$
Operating Case Temperature Range	T_C	–15 to +70	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	$^\circ\text{C/W}$

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_B = 0$)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 19$ V, $I_E = 0$)	I_{CBO}	—	—	15	mAdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 10$ V)	h_{FE}	20	—	80	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	18	20	pF
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(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 25\text{ V}$, $P_{out} = 14\text{ W}$, $f = 860\text{ MHz}$, $I_C = 2 \times 900\text{ mA}$)	G_{PE}	10	—	—	dB
Overdrive (no degradation) ($f = 470\text{ MHz}$, $V_{CE} = 25\text{ V}$, $I_C = 2 \times 900\text{ mA}$)	P_{inover}	12.5	—	—	W
Intermodulation Distortion, 3 Tone ($f = 860\text{ MHz}$, $V_{CE} = 25\text{ V}$, $I_E = 2 \times 900\text{ mA}$, $P_{ref} = 14\text{ W}$, Vision Carrier = -7 dB , Sound Carrier = -8 dB , Sideband Signal = -16 dB , Specification TV05001)	IMD_1	—	-48	-47	dB

Advance Information

The RF Line

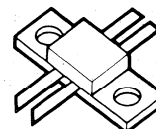
UHF Linear Power Transistor

... specifically designed for high power vision or sound TV amplifiers operating Class AB in Band IV and V. The TPV695B incorporates push-pull package technology, gold metallized dice with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 30 W — P_{out}
- 26 V — V_{CC}
- High Gain — 9.5 dB Typ, Class AB, @ $f = 860$ MHz
- Push-Pull Package

TPV695B

30 W — 470–860 MHz
**UHF LINEAR
 POWER TRANSISTOR**



**BMA2
 CASE 395-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	3	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS (Note 1)

Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $R_{BE} = 75 \Omega$)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 24$ V, $I_E = 0$)	I_{CBO}	—	—	10	mA

ON CHARACTERISTICS (Note 1)

DC Current Gain ($I_C = 500$ mA, $V_{CE} = 10$ V)	h_{FE}	20	—	100	—
--	----------	----	---	-----	---

DYNAMIC CHARACTERISTICS (Note 1)

Output Capacitance ($V_{CB} = 24$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	—	25	pF
--	----------	---	---	----	----

FUNCTIONAL TESTS (Note 2)

Common-Emitter Amplifier Power Gain ($V_{CE} = 26$ V, $P_{out} = 30$ W, $f = 860$ MHz, $I_Q = 2 \times 50$ mA)	G_{PE}	8.5	9.5	—	dB
Collector Efficiency ($V_{CE} = 26$ V, $P_{out} = 30$ W, $f = 860$ MHz, $I_Q = 2 \times 50$ mA)	η	45	50	—	%
Output Power, 1 dB Compression Point ($V_{CE} = 26$ V, $f = 860$ MHz, $I_Q = 2 \times 50$ mA, $P_{ref} = 10$ W)	$P_{o1\text{ dB}}$	30	—	—	W

Notes: 1. Each transistor chip measured separately.
 2. Both transistor chips operating in a push-pull amplifier.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Advance Information

The RF Line

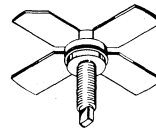
UHF Linear Power Transistor

... designed for 4 watt stages in Band V TV transposer amplifiers. Gold metallized dice and diffused emitter ballast resistors are used to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 4 W — P_{ref} @ –54 dB IMD
- 25 V — V_{CC}
- High Gain — 9 dB Typ, Class A @ $f = 860$ MHz
- Gold Metallization for Reliability

TPV698

4 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	27	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	5	°C/W
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	0.4 Typ	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_B = 0$)	$V_{(BR)CEO}$	27	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CBO}$	48	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 1$ A, $V_{CE} = 10$ V)	h_{FE}	10	—	—	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 24$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	20	22	pF
--	----------	---	----	----	----

FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain ($V_{CE} = 25$ V, $P_{out} = 4$ W, $f = 860$ MHz, $I_C = 850$ mA)	G_{PE}	8.5	9	—	dB
Intermodulation Distortion, 3 Tone ($f = 860$ MHz, $V_{CE} = 25$ V, $I_E = 850$ mA, $P_{ref} = 4$ W, Vision Carrier = –8 dB, Sound Carrier = –7 dB, Sideband Signal = –16 dB, Specification TV05001)	IMD ₁	—	—	–54	dB
Cutoff Frequency ($V_{CE} = 25$ V, $I_C = 850$ mA)	f_T	—	2	—	GHz

This document contains information on a new product. Specifications and information herein are subject to change without notice.

The RF Line

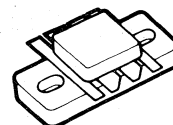
VHF Linear Power Transistor

... designed for linear, push-pull amplifiers in VHF Band III. The TPV3100 utilizes gold metallization, diffused emitter ballast resistors and a low thermal resistance header to ensure long term reliability.

- Band III (170–230 MHz)
- 28 W — P_{ref} @ –51 dB IMD
- 28 V — V_{CC}
- High Gain — 14 dB, Class A @ $f = 225$ MHz
- Push-Pull Package
- Gold Metallization for Reliability

TPV3100

28 V — 170–230 MHz
VHF LINEAR
POWER TRANSISTOR



MRP 7
CASE 827-01/1, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	8	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70^\circ\text{C}$)	$R_{\theta JC}$	0.8	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
----------------	--------	-----	-----	-----	------

OFF CHARACTERISTICS

Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_B = 0$)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mA, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $R_{BE} = 15 \Omega$)	$V_{(BR)CER}$	60	—	—	Vdc

ON CHARACTERISTICS

DC Current Gain ($I_C = 0.5$ A, $V_{CE} = 28$ V)	h_{FE}	20	—	150	—
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DYNAMIC CHARACTERISTICS

Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, $f = 1$ MHz)	C_{ob}	—	60	—	pF
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(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain ($V_{CE} = 28\text{ V}$, $P_{out} = 28\text{ W}$, $f = 225\text{ MHz}$, $I_C = 2 \times 2.25\text{ A}$)	GPE	14	—	—	dB
Load Mismatch ($V_{CE} = 28\text{ V}$, $P_{out} = 28\text{ W}$, $f = 225\text{ MHz}$, Load VSWR = $\infty:1$, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone ($f = 225\text{ MHz}$, $V_{CE} = 28\text{ V}$, $I_E = 2 \times 2.25\text{ A}$, $P_{ref} = 28\text{ W}$, Vision Carrier = -8 dB , Sound Carrier = -7 dB , Sideband Signal = -16 dB , Specification TV05001)	IMD ₁	—	—	-51	dB
Output Power, 1 dB Compression Point ($V_{CE} = 28\text{ V}$, $f = 225\text{ MHz}$, $I_Q = 2 \times 100\text{ mA}$, $P_{ref} = 28\text{ W}$)	P _{o1} dB	100	—	—	W

CLASS A TYPICAL VALUES

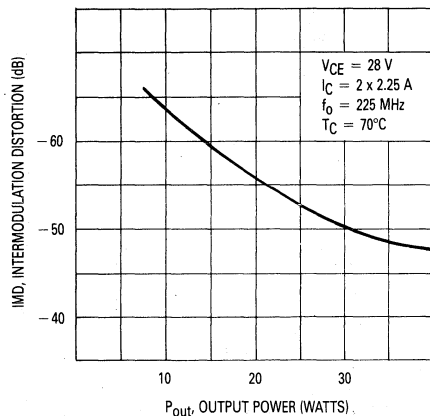


Figure 1. IMD versus Output Power

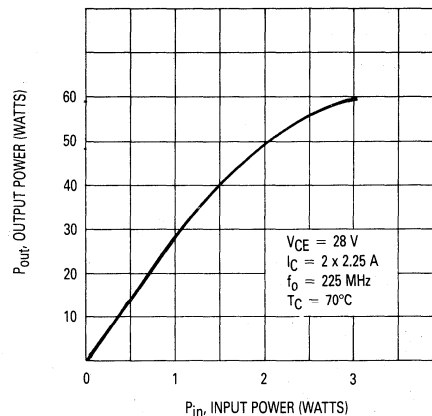
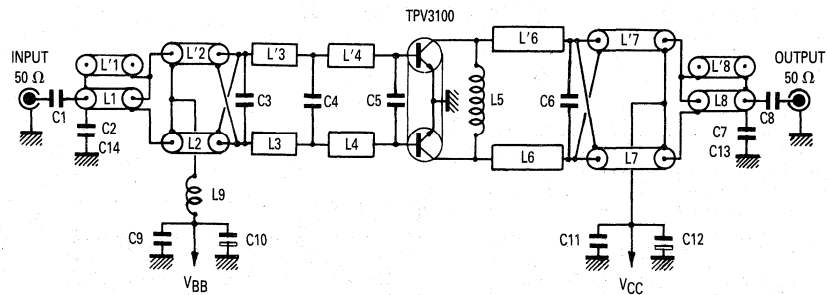


Figure 2. Output Power versus Input Power (CW)

Class A Large Signal Impedances

f_o (MHz)	Z_{in} (Ohms)	Z_{Load} (Ohms)
170	$1 + j0.6$	$14.5 + j10$
200	$0.9 + j1$	$12.5 + j7$
230	$1.2 + j2$	$10.5 + j8.2$

NOTES: $V_{CE} = 28\text{ V}$, $I_C = 2 \times 2.25\text{ A}$
 Z_{in} : Values for optimum input return loss.
 Z_{Load} : Values for best IMD at 28 W ref.



- | | |
|--|---|
| L1, L8 — 80 mm teflon coaxial cable 50 ohms | C1, C2 — 4700 pF chip capacitor |
| L2, L7 — 80 mm teflon coaxial cable 25 ohms | C7, C8 — 4700 pF chip capacitor |
| L3 — 25 mm line W = 1.5 mm on substrate | C3 — 68 pF chip capacitor |
| L4 — 5 mm line W = 1.5 mm on substrate | C4 — 100 pF chip capacitor |
| L5 — 5 turns dia 5 mm, 0.8 mm wire, L = 5 mm | C5 — 220 pF + 22 pF chip capacitor |
| L6 — 33 mm line W = 2 mm on substrate | C6 — 33 pF chip capacitor |
| L9 — 10 turns dia 3 mm, 0.5 mm wire | C9, C11 — 1000 pF + 10 nF + 0.1 μ F chip capacitor |
| | C10 — 1000 μ F 5 V |
| | C12 — 1000 μ F 6 V |
| | C13, C14 — 0.1 μ F chip capacitor substrate teflon-glass 1/50 inch. |

Figure 3. 225 MHz Test Fixture

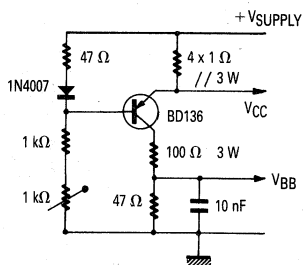


Figure 4. Biasing Circuit

CLASS AB TYPICAL VALUES

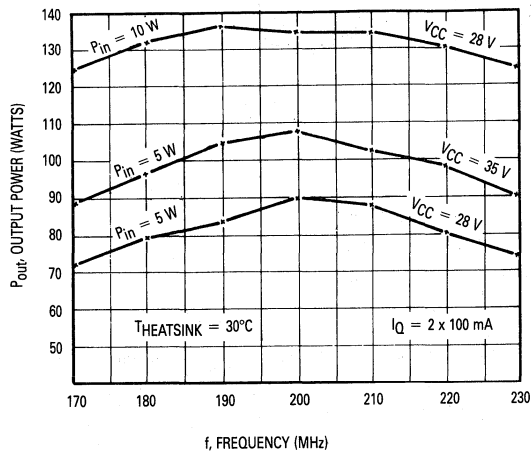


Figure 5. Output Power versus Frequency

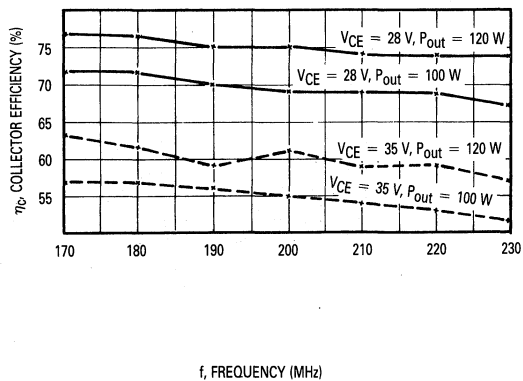


Figure 6. Collector Efficiency versus Frequency

Class AB Large Signal Impedances

Frequency (MHz)	Z_{in} (Ω)	Z_{Load} (Ω)
170	$1.25 + j0.5$	$10 + j10$
200	$0.9 + j0.9$	$9.5 + j7$
230	$1 + j2$	$6.5 + j6.5$

NOTES: $V_{CE} = 28\text{ Volts}$ $I_Q = 2 \times 100\text{ mA}$ $P_{out} = 100\text{ W}$
 — Z_{in} values to get optimum input return loss
 — Z_{Load} values to get optimum output power and efficiency

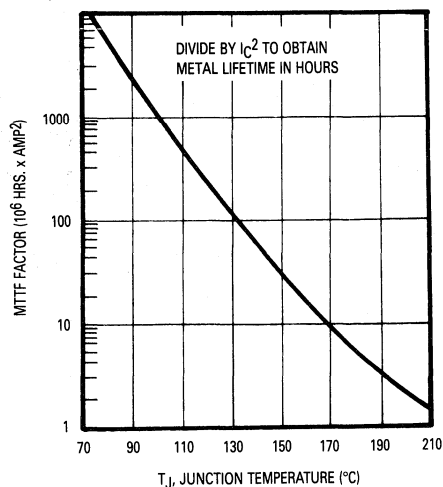
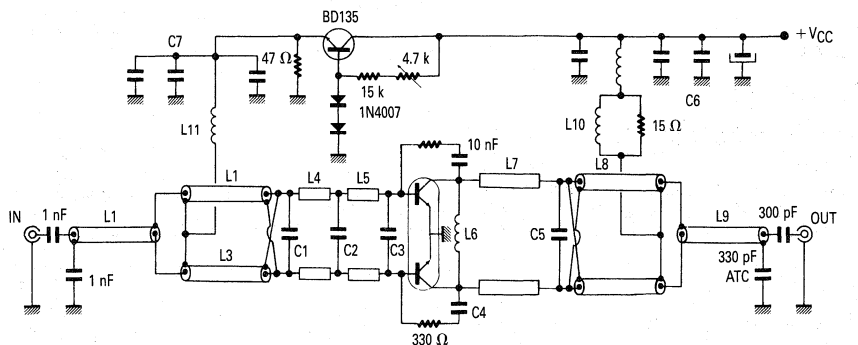


Figure 7. MTTF versus Junction Temperature



L1, L9 — 50 ohms coaxial 1 = 80 mm

L2, L3, L8 — 25 ohms coaxial cable or semi-rigid 1 = 80 mm

L4 — 40 ohms line 2.5% of λ_g 225 MHz or 1 = 23 mm sub 1/50 inch teflon glass

L5 — 40 ohms line 65% λ_g 225 MHz or 1 = 6 mm

L6 — 3 turns ID 4 mm wire 1 mm ϕ leads 5 mm long

L7 — 40 line 3.5% λ_g 225 MHz or 1 = 32 mm 1/50 teflon glass

L10 — 11 turns ID 4 mm wire 1 mm ϕ

L11 — 0.22 μ H molded inductor

C1 — 68 pF ATC 100B

C2 — 100 pF ATC 100B

C3 — 220 pF ATC 100B

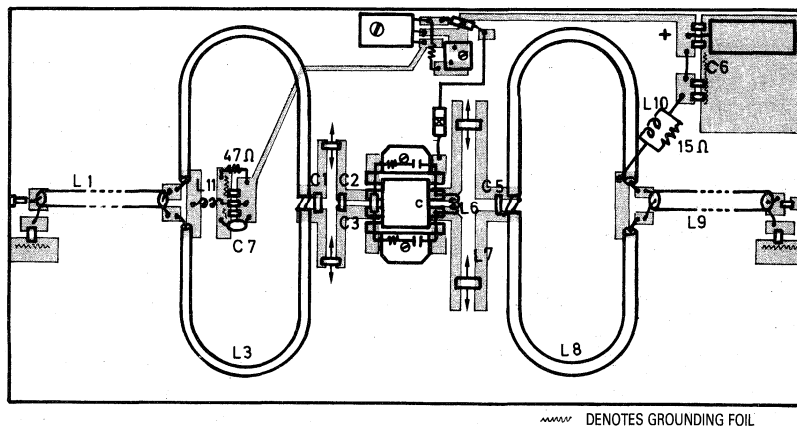
C5 — 27 pF + 33 pF ATC 100A

C6, C7 — 1 nF + 10 nF + 0.1 μ F + electrolytic

L4 has to be adjusted for Gain

L6 and L7 have to be adjusted for the best lead

Figure 8. 170-230 MHz Broadband Amplifier, Class AB



~~~~~ DENOTES GROUNDING FOIL

Figure 9. Components Layout

**The RF Line**  
**VHF Linear**  
**Power Transistor**

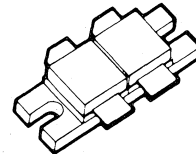
2

... designed for 32 Volt VHF large signal amplifier applications requiring linearity. Internal input matching and use of push-pull packaging technology makes the TPV3250B ideally suited for band III (170–230 MHz) TV transmitter amplifiers.

- Band III (170–230 MHz)
- 240 W —  $P_{out}$
- 32 V —  $V_{CC}$
- High Gain — 10 dB Min, Class AB
- Push-Pull Package
- Gold Metallization for Reliability

**TPV3250B**

**240 W — 230 MHz**  
**VHF LINEAR**  
**POWER TRANSISTOR**



**HPA 1**  
**CASE 397-01, STYLE 1**

**MAXIMUM RATINGS**

| Rating                                                                                 | Symbol    | Value         | Unit                         |
|----------------------------------------------------------------------------------------|-----------|---------------|------------------------------|
| Collector-Emitter Voltage                                                              | $V_{CE}$  | 35            | Vdc                          |
| Collector-Base Voltage                                                                 | $V_{CB}$  | 65            | Vdc                          |
| Emitter-Base Voltage                                                                   | $V_{EB}$  | 4             | Vdc                          |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$     | 210<br>1.82   | Watts<br>W/ $^\circ\text{C}$ |
| Operating Junction Temperature                                                         | $T_J$     | 200           | $^\circ\text{C}$             |
| Storage Temperature Range                                                              | $T_{stg}$ | – 65 to + 200 | $^\circ\text{C}$             |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max  | Unit               |
|--------------------------------------|-----------------|------|--------------------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 0.55 | $^\circ\text{C/W}$ |

**ELECTRICAL CHARACTERISTICS**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                           |               |    |   |   |     |
|---------------------------------------------------------------------------|---------------|----|---|---|-----|
| Collector-Emitter Breakdown Voltage ( $I_C = 100\text{ mA}$ , $I_B = 0$ ) | $V_{(BR)CEO}$ | 35 | — | — | Vdc |
| Collector-Base Breakdown Voltage ( $I_C = 100\text{ mA}$ , $I_E = 0$ )    | $V_{(BR)CBO}$ | 65 | — | — | Vdc |
| Emitter-Base Breakdown Voltage ( $I_E = 20\text{ mA}$ , $I_C = 0$ )       | $V_{(BR)EBO}$ | 4  | — | — | Vdc |

**ON CHARACTERISTICS**

|                                                                 |          |    |   |     |   |
|-----------------------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 1\text{ A}$ , $V_{CE} = 10\text{ V}$ ) | $h_{FE}$ | 20 | — | 150 | — |
|-----------------------------------------------------------------|----------|----|---|-----|---|

**DYNAMIC CHARACTERISTICS**

|                                                                                |          |   |     |   |    |
|--------------------------------------------------------------------------------|----------|---|-----|---|----|
| Output Capacitance ( $V_{CB} = 28\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ ) | $C_{ob}$ | — | 130 | — | pF |
|--------------------------------------------------------------------------------|----------|---|-----|---|----|

**FUNCTIONAL TESTS**

|                                                                                                                                                     |                    |     |   |   |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----|---|---|----|
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 32\text{ V}$ , $P_{out} = 240\text{ W}$ , $f = 230\text{ MHz}$ , $I_Q = 2 \times 0.5\text{ A}$ ) | $G_{PE}$           | 10  | — | — | dB |
| Collector Efficiency<br>( $V_{CE} = 32\text{ V}$ , $P_{out} = 240\text{ W}$ , $f = 230\text{ MHz}$ , $I_Q = 2 \times 0.5\text{ A}$ )                | $\eta_c$           | 60  | — | — | %  |
| Output Power, 1 dB Compression Point<br>( $V_{CE} = 32\text{ V}$ , $f = 230\text{ MHz}$ , $I_Q = 2 \times 0.5\text{ A}$ )                           | $P_{o1\text{ dB}}$ | 240 | — | — | W  |

# Advance Information

## The RF Line

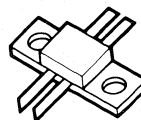
## UHF Linear Power Transistor

... specifically designed for high power vision or sound TV amplifiers operating Class AB in Band IV and V. The TPV5051 incorporates push-pull package technology, gold metallized dice with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 50 W —  $P_{out}$ , Class AB
- 28 V —  $V_{CC}$
- Push-Pull Package
- Gold Metallization for Reliability

**TPV5051**

**50 W — 470 to 860 MHz**  
**UHF LINEAR**  
**POWER TRANSISTOR**



**BMA-2**  
**CASE 395-01, STYLE 1**

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value        | Unit |
|--------------------------------|-----------|--------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 30           | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 45           | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 4            | Vdc  |
| Collector Current — Continuous | $I_C$     | 9            | Adc  |
| Operating Junction Temperature | $T_J$     | 200          | °C   |
| Storage Temperature Range      | $T_{stg}$ | – 65 to +200 | °C   |

### THERMAL CHARACTERISTICS

| Characteristic                                                    | Symbol          | Max     | Unit |
|-------------------------------------------------------------------|-----------------|---------|------|
| Thermal Resistance, Junction to Case ( $T_C = 70^\circ\text{C}$ ) | $R_{\theta JC}$ | 1.8     | °C/W |
| Thermal Resistance, Case to Heatsink                              | $R_{\theta CH}$ | 0.2 Typ | °C/W |

### ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

#### OFF CHARACTERISTICS (Note 1)

|                                                                                      |               |    |   |    |      |
|--------------------------------------------------------------------------------------|---------------|----|---|----|------|
| Collector-Emitter Breakdown Voltage ( $I_C = 60 \text{ mA}$ , $I_B = 0$ )            | $V_{(BR)CEO}$ | 30 | — | —  | Vdc  |
| Collector-Base Breakdown Voltage ( $I_C = 20 \text{ mA}$ , $I_E = 0$ )               | $V_{(BR)CBO}$ | 45 | — | —  | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 6 \text{ mA}$ , $I_C = 0$ )                  | $V_{(BR)EBO}$ | 4  | — | —  | Vdc  |
| Collector-Emitter Breakdown Voltage ( $I_C = 10 \text{ mA}$ , $R_{BE} = 50 \Omega$ ) | $V_{(BR)CER}$ | 40 | — | —  | Vdc  |
| Collector Cutoff Current ( $V_{CE} = 28 \text{ V}$ , $I_B = 0$ )                     | $I_{CEO}$     | —  | — | 10 | mAdc |

#### ON CHARACTERISTICS (Note 1)

|                                                                      |          |    |   |   |   |
|----------------------------------------------------------------------|----------|----|---|---|---|
| DC Current Gain ( $I_C = 800 \text{ mA}$ , $V_{CE} = 20 \text{ V}$ ) | $h_{FE}$ | 10 | — | — | — |
|----------------------------------------------------------------------|----------|----|---|---|---|

#### DYNAMIC CHARACTERISTICS (Note 1)

|                                                                                  |          |   |   |    |    |
|----------------------------------------------------------------------------------|----------|---|---|----|----|
| Output Capacitance ( $V_{CB} = 28 \text{ V}$ , $I_E = 0$ , $f = 1 \text{ MHz}$ ) | $C_{ob}$ | — | — | 40 | pF |
|----------------------------------------------------------------------------------|----------|---|---|----|----|

Note 1. Each transistor chip measured separately.

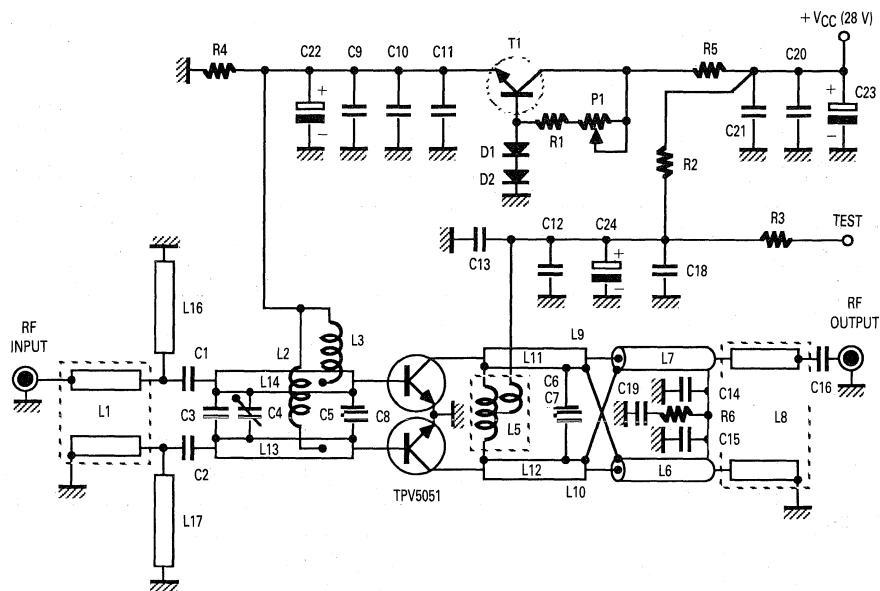
(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

## ELECTRICAL CHARACTERISTICS — continued

| Characteristic                                                                                                                                                          | Symbol   | Min                               | Typ | Max | Unit |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------|-----|-----|------|
| <b>FUNCTIONAL TESTS (Note 2)</b>                                                                                                                                        |          |                                   |     |     |      |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 28 \text{ V}$ , $P_{out} = 50 \text{ W}$ , $f = 860 \text{ MHz}$ , $I_Q = 2 \times 50 \text{ mA}$ )                  | $G_{PE}$ | 6.5                               | —   | 8   | dB   |
| Collector Efficiency<br>( $V_{CE} = 28 \text{ V}$ , $P_{out} = 50 \text{ W}$ , $f = 860 \text{ MHz}$ , $I_Q = 2 \times 50 \text{ mA}$ )                                 | $\eta_c$ | 45                                | —   | —   | %    |
| Load Mismatch<br>( $V_{CE} = 25 \text{ V}$ , $I_Q = 2 \times 50 \text{ mA}$ , $P_{out} = 30 \text{ W}$ , $f = 860 \text{ MHz}$ ,<br>Load VSWR = 10:1, All Phase Angles) | $\psi$   | No Degradation in<br>Output Power |     |     |      |

Note 2. Both transistor chips operating in push-pull amplifier.



L9, L10 —  $0.05 \lambda$  @ 665 MHz,  $Z_0 = 37 \Omega$   
 L13, L14 —  $0.0156 \lambda$  @ 665 MHz,  $Z_0 = 50 \Omega$   
 L11, L12 —  $0.014 \lambda$  @ 665 MHz,  $Z_0 = 50 \Omega$   
 L16, L17 —  $0.13 \lambda$  @ 665 MHz,  $Z_0 = 50 \Omega$

C1, C2 — Capacitor Chip 15 pF 5%  
 C3 — Capacitor Chip 5.6 pF 5%  
 C4, C8 — Capacitor Adjust. 1-4 pF  
 C5 — Capacitor Chip 22 pF  
 C6 — Capacitor Chip 12 pF 5%  
 C7 — Capacitor Chip 4.7 pF 5%  
 C9, C10, C13, C15 — Capacitor Chip 330 pF  
 C11, C12, C14, C20 — Capacitor Chip 0.1  $\mu$ F  
 C16, C17 — Capacitor Chip 100 pF 10%  
 C18, C21 — Capacitor Chip 15 nF  
 C19 — Capacitor Chip 1 nF

C22, C23 — Capacitor, Electrolytic 100  $\mu$ F  
 C24 — Capacitor, Electrolytic 10  $\mu$ F

R1 — Resistor 1/2 W 1 k $\Omega$   
 R2 — Resistor 0.1  $\Omega$  1%  
 R3, R5 — Resistor 1/2 W 100  $\Omega$   
 R4 — Resistor 1/2 W 33  $\Omega$   
 R6 — Resistor 1/4 W 10  $\Omega$

L1 — Bifilar Inductor  
 L2, L3 — Inductor, Molded 0.47  $\mu$ H  
 L5 — Inductor  
 L6, L7 — Cable, Coaxial 25  $\Omega$   
 L8 — Bifilar Inductor

T1 — Transistor BD135

Figure 1. 860 MHz Test Circuit

## The RF Line

# UHF Linear Power Transistor

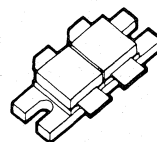
... designed for output stages in Band IV & V TV transmitter amplifiers. Internal matching of both input and output along with use of a push-pull package configuration aids broadband amplifier designs.

Gold metallized dice with diffused emitter ballast resistors enhances reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 50 W —  $P_{out}$ , Class AB
- 28 V —  $V_{CC}$
- Push-Pull Package
- Gold Metallization for Reliability

**TPV5055B**

**50 W — 470 to 860 MHz**  
**UHF LINEAR**  
**POWER TRANSISTOR**



**BMA-4**  
**CASE 398-01, STYLE 1**

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 30          | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 45          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 4           | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | –65 to +200 | °C   |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 1.5 | °C/W |

### ELECTRICAL CHARACTERISTICS

| Characteristic                                                   | Symbol        | Min | Typ | Max | Unit |
|------------------------------------------------------------------|---------------|-----|-----|-----|------|
| <b>OFF CHARACTERISTICS</b>                                       |               |     |     |     |      |
| Collector-Emitter Breakdown Voltage ( $I_C = 40$ mA, $I_B = 0$ ) | $V_{(BR)CEO}$ | 30  | —   | —   | Vdc  |
| Collector-Base Breakdown Voltage ( $I_C = 20$ mA, $I_E = 0$ )    | $V_{(BR)CBO}$ | 45  | —   | —   | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 6$ mA, $I_C = 0$ )       | $V_{(BR)EBO}$ | 4   | —   | —   | Vdc  |
| Collector Cutoff Current ( $V_{CE} = 28$ V, $V_{BE} = 0$ )       | $I_{CES}$     | —   | —   | 10  | mA   |
| <b>ON CHARACTERISTICS</b>                                        |               |     |     |     |      |
| DC Current Gain ( $I_C = 1$ A, $V_{CE} = 10$ V)                  | $h_{FE}$      | 10  | —   | —   | —    |

### DYNAMIC CHARACTERISTICS

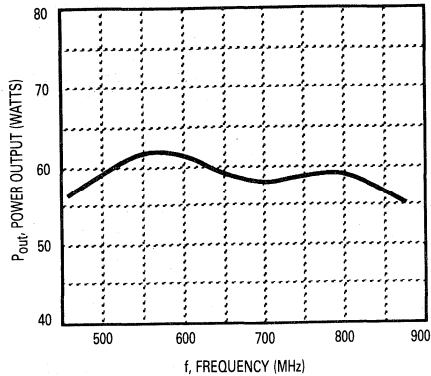
|                                                                |          |   |    |   |    |
|----------------------------------------------------------------|----------|---|----|---|----|
| Output Capacitance ( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | 38 | — | pF |
|----------------------------------------------------------------|----------|---|----|---|----|

### FUNCTIONAL TESTS

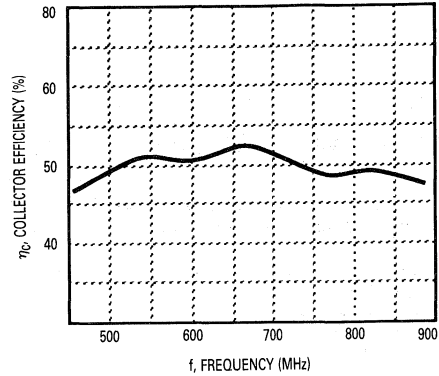
|                                                                                                                           |                    |    |    |   |    |
|---------------------------------------------------------------------------------------------------------------------------|--------------------|----|----|---|----|
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 28$ V, $P_{out} = 50$ W, $f = 860$ MHz, $I_{CQ} = 2 \times 200$ mA)    | $G_{PE}$           | 7  | —  | — | dB |
| Collector Efficiency<br>( $V_{CE} = 28$ V, $P_{out} = 50$ W, $f = 860$ MHz, $I_{CQ} = 2 \times 200$ mA)                   | $\eta$             | 45 | 50 | — | %  |
| Output Power, 1 dB Compression Point<br>( $V_{CE} = 28$ V, $f = 860$ MHz, $I_{CQ} = 2 \times 200$ mA, $P_{ref} = 12.5$ W) | $P_{01\text{ dB}}$ | 50 | —  | — | W  |



**TYPICAL BROADBAND RESULTS**  
 $V_{CC} = 28 \text{ V}$   $I_{CQ} = 2 \times 200 \text{ mA}$   
**FREQUENCY: 470–860 MHz**

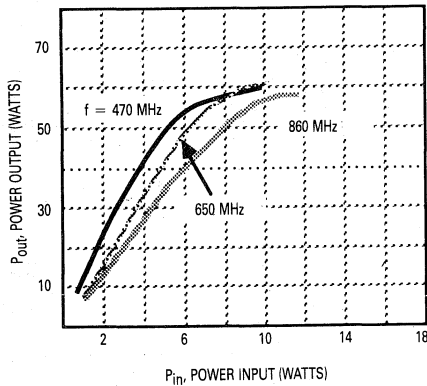


**Figure 1. Power Output at 1 dB Compression versus Frequency**

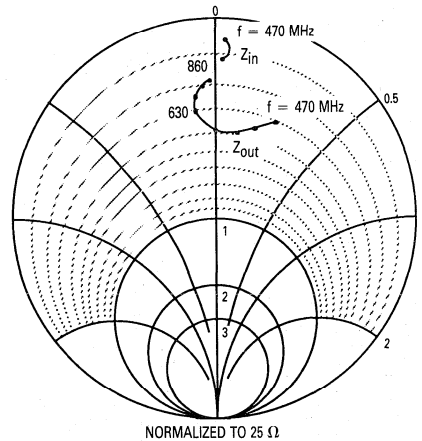


**Figure 2. Collector Efficiency versus Frequency**

**TYPICAL CHARACTERISTICS**



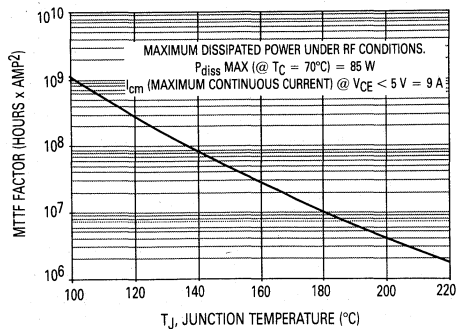
**Figure 3. Power Output versus Power Input**



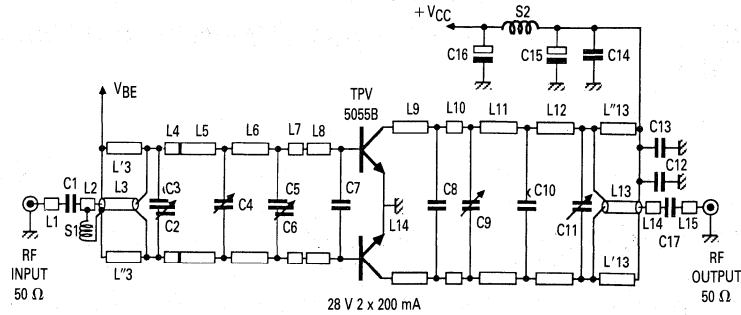
| f (MHz) | $Z_{in} (\Omega)$ | $Z_{out} (\Omega)$ |
|---------|-------------------|--------------------|
| 470     | $1.5 + j0.65$     | $7.8 + j5.3$       |
| 520     |                   | $9 + j4.5$         |
| 565     | $1.9 + j1$        | $10 + j2.5$        |
| 590     |                   | $10 + j0$          |
| 630     | $2.5 + j1$        | $7.8 - j2$         |
| 680     |                   | $6 - j1.7$         |
| 765     | $2.9 + j0.8$      | $5 - j1$           |
| 860     | $3 + j0.5$        | $4.5 - j0.5$       |

$P_{out}$  = @ 1 dB Compression  
 $V_{CC} = 28 \text{ V}$ ,  $I_{CQ} = 2 \times 200 \text{ mA}$

**Figure 5.  $Z_{IN}$  and  $Z_{OUT}$  versus Frequency (Each side)**

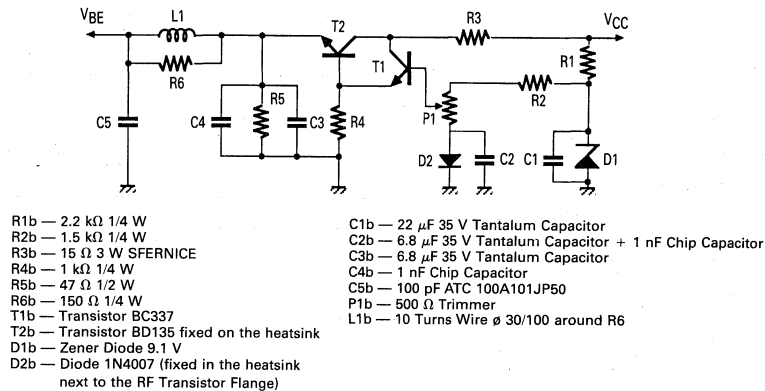


**Figure 4. MTTF Factor versus Junction Temperature**  
(MTTF — Hrs.  $\times A^2$  — Divide by  $I_{CQ}^2$  to obtain MTTF in hours)



- |                                           |                                                    |                                                        |
|-------------------------------------------|----------------------------------------------------|--------------------------------------------------------|
| L1 — 50 Ω Printed Line                    | L13 — Coaxial Cable 50 Ω 85 mils L = 75 mm         | C7 — Chip Capacitor 18 pF ATC 100A180DP50              |
| L2 — 50 Ω Printed Line                    | L'13 — 70 Ω Printed Line; Length 75 mm             | C8 — Chip Capacitor 6.8 pF ATC 100A6R8CP50             |
| L3 — Coaxial Cable 50 Ω 85 mils L = 75 mm | L'13 — 70 Ω Printed Line; Length 75 mm             | C9 — Trimmer Capacitor 0.5/4 pF Ref. 37275 TEKELEC     |
| L'3 — 70 Ω Printed Line; Length 75 mm     | L14 — 40 Ω Printed Line; Length 7 mm               | C10 — 6 mm Coaxial Line 50 Ω Dia. 070                  |
| L4 — 25 Ω Printed Line; Length 2 mm       | S1 — 4 Turns Wire 0.8 mm ID 3 mm                   | C11 — Trimmer Capacitor 0.5/4 pF Ref. 37275 TEKELEC    |
| L5 — 35 Ω Printed Line; Length 22 mm      | S2 — 4 Turns Wire 0.8 mm ID 3 mm                   | C12 — Chip Capacitor 100 pF ATC 100A101JP50            |
| L6 — 35 Ω Printed Line; Length 12 mm      | C1 — Chip Capacitor 100 pF ATC 100A101JP50         | C13 — Chip Capacitor 100 pF ATC 100A101JP50            |
| L7 — 35 Ω Printed Line; Length 2 mm       | C2 — Trimmer Capacitor 0.5/4 pF Ref. 37275 TEKELEC | C14 — Chip Capacitor 1 nF                              |
| L8 — 25 Ω Printed Line; Length 8 mm       | C3 — Chip Capacitor 1.3 pF ATC 100A1R3BP50         | C15 — Chip Tantalum Capacitor 6.8 μF 35 V              |
| L9 — 25 Ω Printed Line; Length 8 mm       | C4 — Trimmer Capacitor 1-4 pF GKU 4R0              | C16 — Capacitor 100 μF 40 V                            |
| L10 — 25 Ω Printed Line; Length 7 mm      | C5 — Chip Capacitor 5.6 pF ATC 100A5R6CP50         | C17 — Chip Capacitor 100 pF ATC 100A101JP50            |
| L11 — 35 Ω Printed Line; Length 15 mm     | C6 — Trimmer Capacitor 0.5/4 pF Ref. 37275 TEKELEC |                                                        |
| L12 — 35 Ω Printed Line; Length 15 mm     |                                                    | Note: L3 & L'13 soldered on 70 Ω printed line L'3/L'13 |

Figure 6. 470-860 MHz Test Circuit, Class AB



- |                                                                             |                                                            |
|-----------------------------------------------------------------------------|------------------------------------------------------------|
| R1b — 2.2 kΩ 1/4 W                                                          | C1b — 22 μF 35 V Tantalum Capacitor                        |
| R2b — 1.5 kΩ 1/4 W                                                          | C2b — 6.8 μF 35 V Tantalum Capacitor + 1 nF Chip Capacitor |
| R3b — 15 Ω 3 W SFRNICE                                                      | C3b — 6.8 μF 35 V Tantalum Capacitor                       |
| R4b — 1 kΩ 1/4 W                                                            | C4b — 1 nF Chip Capacitor                                  |
| R5b — 47 Ω 1/2 W                                                            | C5b — 100 pF ATC 100A101JP50                               |
| R6b — 150 Ω 1/4 W                                                           | P1b — 500 Ω Trimmer                                        |
| T1b — Transistor BC337                                                      | L1b — 10 Turns Wire ø 30/100 around R6                     |
| T2b — Transistor BD135 fixed on the heatsink                                |                                                            |
| D1b — Zener Diode 9.1 V                                                     |                                                            |
| D2b — Diode 1N4007 (fixed in the heatsink next to the RF Transistor Flange) |                                                            |

Figure 7. Bias Circuit, Class AB

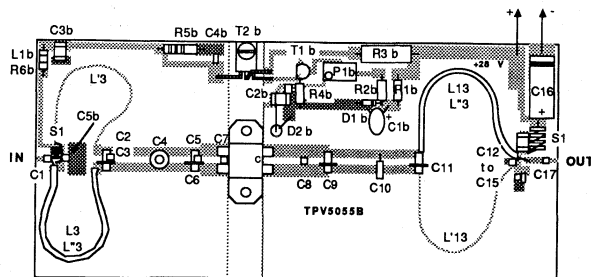


Figure 8. PC Board Layout

## The RF Line

# UHF Linear Power Transistor

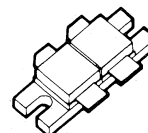
... designed for output stages in Band IV & V TV transmitter amplifiers. Internal matching of both input and output along with use of a push-pull package configuration aids broadband amplifier designs.

Gold metallized dice with diffused emitter ballast resistors enhances reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 80 W —  $P_{out}$ , Class AB @  $f = 860$  MHz
- 90 W —  $P_{out}$ , Class AB @  $f = 650$  MHz
- 28 V —  $V_{CC}$
- Push-Pull Package
- Gold Metallization for Reliability

**TPV6080B**

**80 W — 470 to 860 MHz**  
**UHF LINEAR**  
**POWER TRANSISTOR**



**HPA-1**  
**CASE 397-01, STYLE 1**

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 30          | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 56          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 4           | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | –65 to +200 | °C   |

### THERMAL CHARACTERISTICS

| Characteristic                                                    | Symbol          | Typ | Max | Unit |
|-------------------------------------------------------------------|-----------------|-----|-----|------|
| Thermal Resistance, Junction to Case ( $T_C = 60^\circ\text{C}$ ) | $R_{\theta JC}$ | 0.6 | 0.7 | °C/W |

### ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

#### OFF CHARACTERISTICS (Note 1)

|                                                                  |               |    |   |   |     |
|------------------------------------------------------------------|---------------|----|---|---|-----|
| Collector-Emitter Breakdown Voltage ( $I_C = 60$ mA, $I_B = 0$ ) | $V_{(BR)CEO}$ | 30 | — | — | Vdc |
| Collector-Base Breakdown Voltage ( $I_C = 60$ mA, $I_E = 0$ )    | $V_{(BR)CBO}$ | 56 | — | — | Vdc |
| Emitter-Base Breakdown Voltage ( $I_E = 15$ mA, $I_C = 0$ )      | $V_{(BR)EBO}$ | 4  | — | — | Vdc |

#### ON CHARACTERISTICS (Note 1)

|                                                   |          |    |   |    |   |
|---------------------------------------------------|----------|----|---|----|---|
| DC Current Gain ( $I_C = 1.5$ A, $V_{CE} = 10$ V) | $h_{FE}$ | 20 | — | 80 | — |
|---------------------------------------------------|----------|----|---|----|---|

#### DYNAMIC CHARACTERISTICS (Note 1)

|                                                                |          |   |    |   |    |
|----------------------------------------------------------------|----------|---|----|---|----|
| Output Capacitance ( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | 60 | — | pF |
|----------------------------------------------------------------|----------|---|----|---|----|

Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

| Characteristic                                                                                                                                          | Symbol              | Min | Typ | Max | Unit |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----|-----|-----|------|
| <b>FUNCTIONAL TESTS (Note 2)</b>                                                                                                                        |                     |     |     |     |      |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 80\text{ W}$ , $f = 860\text{ MHz}$ , $I_{CQ} = 2 \times 250\text{ mA}$ )  | $G_{PE1}$           | 7   | —   | —   | dB   |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 90\text{ W}$ , $f = 650\text{ MHz}$ , $I_{CQ} = 2 \times 250\text{ mA}$ )  | $G_{PE2}$           | 8   | —   | —   | dB   |
| Collector Efficiency — 1<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 80\text{ W}$ , $f = 860\text{ MHz}$ , $I_{CQ} = 2 \times 250\text{ mA}$ )             | $\eta_{c1}$         | 40  | 50  | —   | %    |
| Collector Efficiency — 2<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 90\text{ W}$ , $f = 650\text{ MHz}$ , $I_{CQ} = 2 \times 250\text{ mA}$ )             | $\eta_{c2}$         | 45  | 55  | —   | %    |
| Output Power, 1 dB Compression Point<br>( $V_{CE} = 28\text{ V}$ , $f = 860\text{ MHz}$ , $I_{CQ} = 2 \times 250\text{ mA}$ , $P_{ref} = 15\text{ W}$ ) | $P_{o1\text{ dB}1}$ | 80  | —   | —   | W    |
| Output Power, 1 dB Compression Point<br>( $V_{CE} = 28\text{ V}$ , $f = 650\text{ MHz}$ , $I_{CQ} = 2 \times 250\text{ mA}$ , $P_{ref} = 15\text{ W}$ ) | $P_{o1\text{ dB}2}$ | 90  | —   | —   | W    |

Note 2. Both transistor chips operating in push-pull amplifier.

TYPICAL CHARACTERISTICS

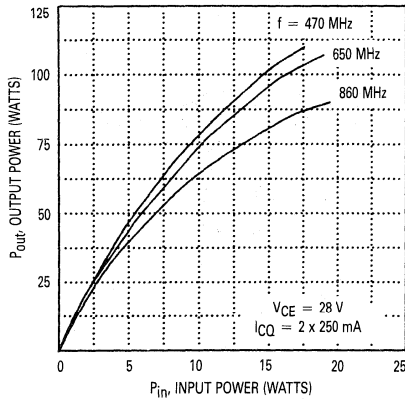


Figure 1. Output Power versus Input Power

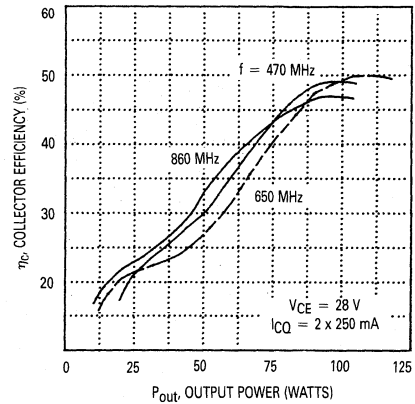


Figure 2. Collector Efficiency versus Output Power

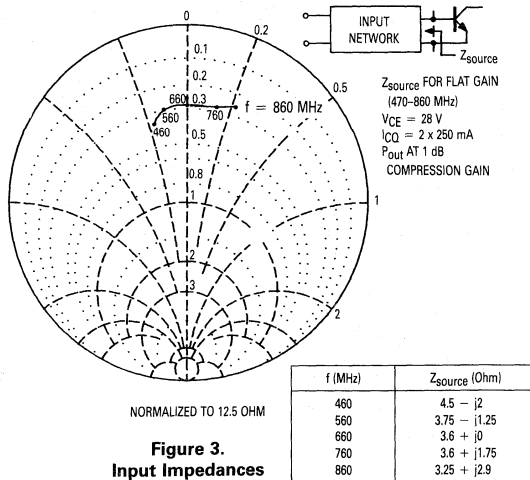


Figure 3. Input Impedances

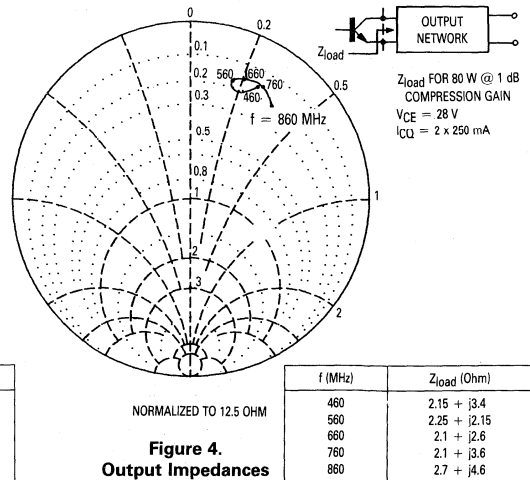
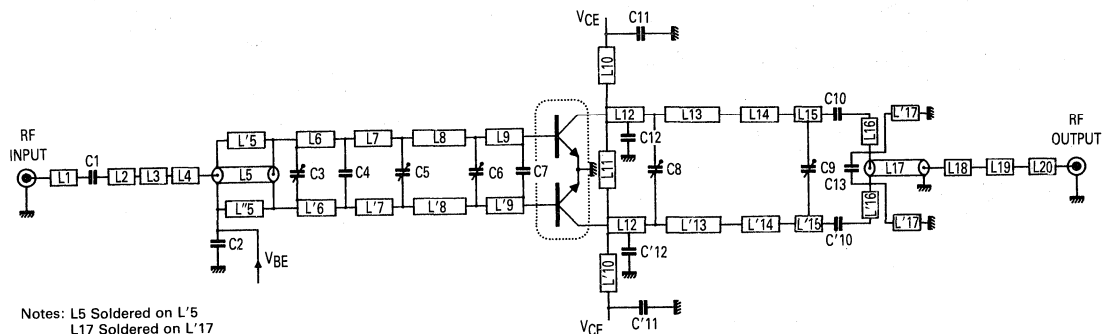


Figure 4. Output Impedances

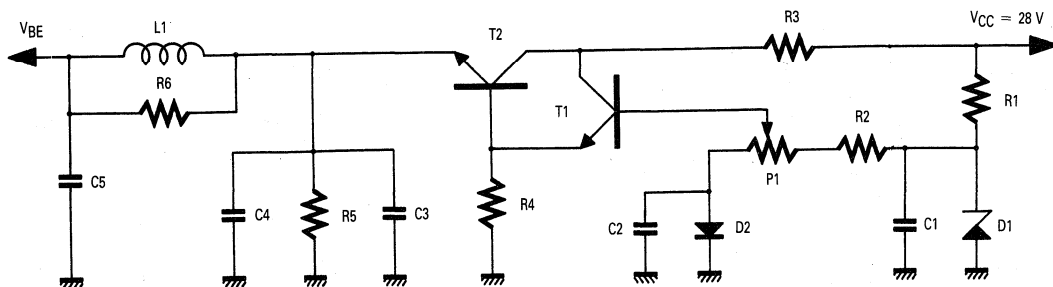


### Components List

- |                                                  |                                                          |
|--------------------------------------------------|----------------------------------------------------------|
| L1, L2, L20 — Printed Line 50 Ohms               | L16, L'16 — Printed Line 25 Ohms 2.5 mm                  |
| L3, L19 — Printed Line 26.7 Ohms 18 mm           | C1 — Chip Capacitor ATC100A101JP50                       |
| L4, L18 — Printed Line 60 Ohms 18.5 mm           | C2 — ATC100A101JP50 + 1 nF + 0.1 MF + 22 MF              |
| L5, L17 — Coaxial Cable 25 Ohms 43 mm            | C3, C5, C6 — Trimmer Capacitor 0-4 pF GKU                |
| L'5, L'6, L'7, L'17 — Printed Line 50 Ohms 43 mm | C4 — Capacitor ATC100A3R9CP50                            |
| L6, L'6 — Printed Line 25 Ohms 13.5 mm           | C7 — Capacitor ATC100A8R2DP50                            |
| L7, L'7 — Printed Line 8 Ohms 15 mm              | C8 — Trimmer 0.5-4 pF TEKELEC                            |
| L8, L'8 — Printed Line 10.5 Ohms 12.5 mm         | + ATC100A 5R6CP50 + 2R2CP50                              |
| L9, L'9 — Printed Line 8 Ohms 7.5 mm             | C9 — Trimmer 0.5-4 pF TEKELEC                            |
| L10, L'10 — Printed Line 50 Ohms 8 mm            | C10, C'10 — 2 Chips // ATC100A101JP50                    |
| L11 — Printed Line 70 Ohms 9 mm                  | C11, C'11 — Capacitor ATC100A101JP50                     |
| L12, L'12 — Printed Line 9.5 Ohms 10.5 mm        | + Capacitor Chip 1 NF                                    |
| L13, L'13 — Printed Line 11 Ohms 14.5 mm         | C12, C'12 — Capacitor ATC100B150DP                       |
| L14, L'14 — Printed Line 15.3 Ohms 8.5 mm        | C13 — Capacitor ATC100A2R2CP50                           |
| L15, L'15 — Printed Line 19 Ohms 3.5 mm          | PCB Material: Teflon Glass 1/50 Inch $\epsilon_r = 2.55$ |

Figure 5. 860 MHz Test Fixture

$V_{CE} = 28 \text{ V}$ ,  $I_{CQ} = 2 \times 250 \text{ mA}$



### Components List

- |                                                                  |                                          |
|------------------------------------------------------------------|------------------------------------------|
| R1 — Resistor 2.2 k Ohms 1/4 W                                   | C1 — Capacitor 22 MF 35 V                |
| R2 — Resistor 1.5 k Ohms 1/4 W                                   | C2 — Capacitor 6.8 MF 35 V               |
| R3 — Resistor 15 Ohms 3 W                                        | + 1 nF Chip Capacitor                    |
| R4 — Resistor 1 k Ohms 1/4 W                                     | C3 — Capacitor 6.8 MF 35 V               |
| R5 — Resistor 47 Ohms 1/2 W                                      | C4 — Capacitor 1 NF                      |
| R6 — Resistor 150 Ohms 1/4 W                                     | C5 — Capacitor ATC100A101JP50            |
| T1 — Transistor BC337                                            | P1 — Trimmer 500 Ohms                    |
| T2 — Transistor BD135 on heatsink                                | L1 — 10 turns Wire $\phi$ 3/10 around R6 |
| D1 — Zener Diode 9.1 V                                           |                                          |
| D2 — Diode 1N4007 fixed on heatsink next to RF Transistor Flange |                                          |

Figure 6. Bias Circuit, Class AB

## The RF Line

# UHF Linear Power Transistor

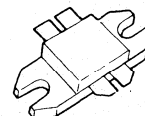
... designed for output stages in Band IV & V TV transmitter amplifiers. Internal matching of both input and output along with use of a push-pull package configuration aids broadband amplifier designs.

Gold metallized dice with diffused emitter ballast resistors enhances reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 25 W —  $P_{ref}$  @ –45 dB IMD
- 25 V —  $V_{CC}$
- Push-Pull Package
- Gold Metallization for Reliability

**TPV7025**

**25 W — 470 to 860 MHz**  
**UHF LINEAR**  
**POWER TRANSISTOR**



**BMA-4**  
**CASE 398-01, STYLE 1**

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 28          | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 45          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 4           | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | –50 to +200 | °C   |
| Operating Case Temperature     | $T_C$     | 70          | °C   |

### THERMAL CHARACTERISTICS

| Characteristic                                                    | Symbol          | Max | Unit |
|-------------------------------------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case ( $T_C = 70^\circ\text{C}$ ) | $R_{\theta JC}$ | 1.5 | °C/W |

### ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

#### OFF CHARACTERISTICS (Note 1)

|                                                                           |               |    |   |   |     |
|---------------------------------------------------------------------------|---------------|----|---|---|-----|
| Collector-Emitter Breakdown Voltage ( $I_C = 120\text{ mA}$ , $I_B = 0$ ) | $V_{(BR)CEO}$ | 28 | — | — | Vdc |
| Collector-Base Breakdown Voltage ( $I_C = 20\text{ mA}$ , $I_E = 0$ )     | $V_{(BR)CBO}$ | 45 | — | — | Vdc |
| Emitter-Base Breakdown Voltage ( $I_E = 6\text{ mA}$ , $I_C = 0$ )        | $V_{(BR)EBO}$ | 4  | — | — | Vdc |

#### ON CHARACTERISTICS (Note 1)

|                                                                 |          |    |   |    |   |
|-----------------------------------------------------------------|----------|----|---|----|---|
| DC Current Gain ( $I_C = 1\text{ A}$ , $V_{CE} = 20\text{ V}$ ) | $h_{FE}$ | 10 | — | 60 | — |
|-----------------------------------------------------------------|----------|----|---|----|---|

#### DYNAMIC CHARACTERISTICS (Note 1)

|                                                                                |          |    |   |    |    |
|--------------------------------------------------------------------------------|----------|----|---|----|----|
| Output Capacitance ( $V_{CB} = 28\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ ) | $C_{ob}$ | 64 | — | 80 | pF |
|--------------------------------------------------------------------------------|----------|----|---|----|----|

Note 1. Each transistor chip measured separately.

(continued)

## ELECTRICAL CHARACTERISTICS — continued

| Characteristic                                                                                                                                                                                                                                                               | Symbol              | Min                            | Typ | Max   | Unit |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------------|-----|-------|------|
| <b>FUNCTIONAL TESTS (Note 2)</b>                                                                                                                                                                                                                                             |                     |                                |     |       |      |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 25\text{ V}$ , $P_{out} = 25\text{ W}$ , $f = 860\text{ MHz}$ , $I_{CQ} = 3.2\text{ A}$ )                                                                                                                                 | G <sub>PE</sub>     | 9                              | —   | 10.5  | dB   |
| Load Mismatch<br>( $V_{CE} = 25\text{ V}$ , $P_{out} = 24\text{ W}$ , $f = 860\text{ MHz}$ ,<br>Load VSWR = $\infty:1$ , All Phase Angles)                                                                                                                                   | $\psi$              | No Degradation in Output Power |     |       |      |
| Overdrive ( $f = 470\text{ MHz}$ , 2 tones, $V_{CE} = 25\text{ V}$ , $I_C = 3.2\text{ A}$ )<br>(No Degradation)                                                                                                                                                              | P <sub>inover</sub> | 24                             | —   | —     | W    |
| Intermodulation Distortion, 3 Tone<br>( $f = 860\text{ MHz}$ , $V_{CE} = 25\text{ V}$ , $I_E = 3.2\text{ A}$ , $P_{ref} = 25\text{ W}$ ,<br>Vision Carrier = $-8\text{ dB}$ , Sound Carrier = $-7\text{ dB}$ ,<br>Sideband Signal = $-16\text{ dB}$ , Specification TV05001) | IMD <sub>1</sub>    | —                              | —   | $-45$ | dB   |
| Cross Modulation Distortion<br>( $P_{ref} = 25\text{ W}$ , $f = 860\text{ MHz}$ , $\Delta\%$ Sound = $(-7\text{ dB})$ , Vision 0 — Peak)                                                                                                                                     | X <sub>MOD</sub>    | —                              | —   | 20    | %    |

Note 2. Both transistor chips operating in push-pull amplifier.

## TYPICAL CHARACTERISTICS

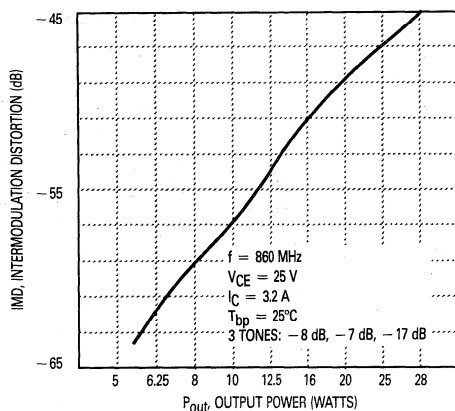


Figure 1. IMD versus Output Power

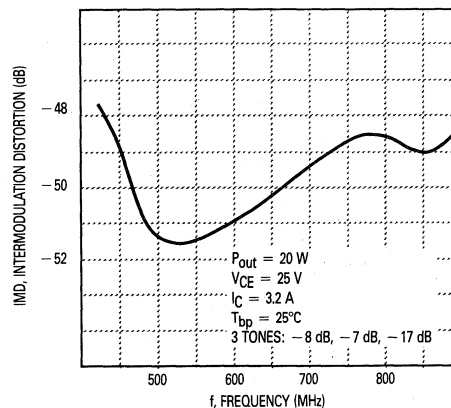


Figure 2. IMD versus Frequency

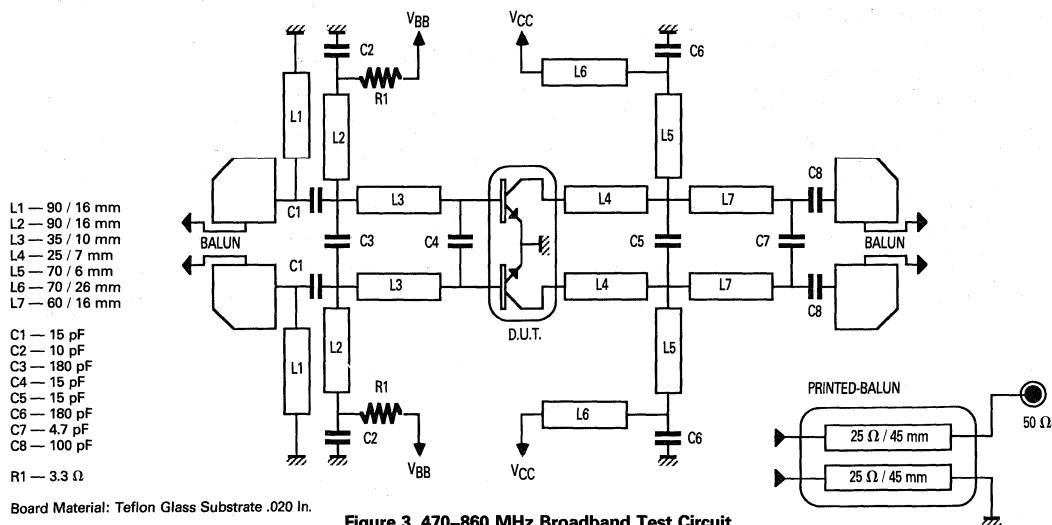


Figure 3. 470-860 MHz Broadband Test Circuit

| FREQUENCY<br>MHz | S11   |       | S21   |        | S12    |        | S22    |        |
|------------------|-------|-------|-------|--------|--------|--------|--------|--------|
|                  | MAG   | ANG   | MAG   | ANG    | MAG    | ANG    | MAG    | ANG    |
| 440              | -0.01 | 177.8 | 1.97  | 80.4   | -33.02 | 29.2   | -0.97  | 157.9  |
| 460              | -0.01 | 175.8 | 1.91  | 84.0   | -33.30 | 30.5   | -2.21  | 150.5  |
| 480              | -0.02 | 173.8 | 2.29  | 80.6   | -33.06 | 30.2   | -3.06  | 147.7  |
| 500              | -0.07 | 172.5 | 2.89  | 74.9   | -32.42 | 28.7   | -3.79  | 144.5  |
| 520              | -0.15 | 171.0 | 3.07  | 69.6   | -31.35 | 26.4   | -4.61  | 141.5  |
| 540              | -0.27 | 172.5 | 3.62  | 64.7   | -30.52 | 17.4   | -5.49  | 140.2  |
| 560              | -0.27 | 171.0 | 4.48  | 67.3   | -30.01 | 12.1   | -6.68  | 139.3  |
| 580              | -0.53 | 168.8 | 4.97  | 49.4   | -29.20 | 07.6   | -8.11  | 138.0  |
| 600              | -0.77 | 164.0 | 5.72  | 39.5   | -28.27 | 00.2   | -10.28 | 142.0  |
| 620              | -1.04 | 162.7 | 6.25  | 29.7   | -27.45 | -8.6   | -12.77 | 156.7  |
| 640              | -1.36 | 163.0 | 6.80  | 17.6   | -26.55 | -18.9  | -13.49 | -172.7 |
| 660              | -1.75 | 164.0 | 7.21  | 03.9   | -25.94 | -30.0  | -10.54 | -150.2 |
| 680              | -2.05 | 166.2 | 7.18  | -11.3  | -25.79 | -41.8  | -7.26  | -146.5 |
| 700              | -2.10 | 168.8 | 6.69  | -26.3  | -25.95 | -55.0  | -4.90  | -149.6 |
| 720              | -2.00 | 170.5 | 5.98  | -40.1  | -26.07 | -66.4  | -3.29  | -154.6 |
| 740              | -1.75 | 171.7 | 5.12  | -51.6  | -26.71 | -76.0  | -2.28  | -161.4 |
| 760              | -1.48 | 172.2 | 4.03  | -63.1  | -27.60 | -86.5  | -1.64  | -167.8 |
| 780              | -1.27 | 171.9 | 2.80  | -74.0  | -28.46 | -95.8  | -1.31  | -173.1 |
| 800              | -1.13 | 170.8 | 1.83  | -82.1  | -29.13 | -101.9 | -1.15  | -177.7 |
| 820              | -1.04 | 170.2 | 0.85  | -88.4  | -29.87 | -106.0 | -1.08  | 178.2  |
| 840              | -0.96 | 169.7 | -0.11 | -93.8  | -30.62 | -109.9 | -1.01  | 175.0  |
| 860              | -0.96 | 168.9 | -1.03 | -100.2 | -31.39 | -114.5 | -1.08  | 172.1  |
| 880              | -0.91 | 168.4 | -1.98 | -107.0 | -31.93 | -119.1 | -1.21  | 170.0  |

Conditions: 25V 2 X 1.8 A

Figure 4. Common Emitter S-Parameters



## The RF Line

# Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 2.3 GHz frequency range.

- Designed for Class B or C, Common Base Power Amplifiers
- Specified 28 Volt, 2 GHz Characteristics:
  - Output Power — 1 to 20 Watts
  - Power Gain — 5.2 to 9 dB, Min
  - Collector Efficiency — 40%, Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

### MAXIMUM RATINGS

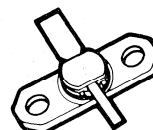
| Rating                         | Symbol           | 2001,F       | 2003,F | 2005,F | 2010,F | 2015 | 2020 | Unit |
|--------------------------------|------------------|--------------|--------|--------|--------|------|------|------|
| Collector-Base Voltage         | V <sub>CES</sub> | 50           |        |        |        |      |      | Vdc  |
| Emitter-Base Voltage           | V <sub>EBO</sub> | 3.5          |        |        |        |      |      | Vdc  |
| Collector Current — Continuous | I <sub>C</sub>   | 0.25         | 0.5    | 1      | 2      | 3    | 4    | Adc  |
| Operating Junction Temperature | T <sub>J</sub>   | 200          |        |        |        |      |      | °C   |
| Storage Temperature Range      | T <sub>stg</sub> | - 65 to +200 |        |        |        |      |      | °C   |

### THERMAL CHARACTERISTICS

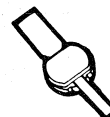
| Characteristic                       | Symbol           | Max |    |     |   |     |   | Unit |
|--------------------------------------|------------------|-----|----|-----|---|-----|---|------|
| Thermal Resistance, Junction to Case | R <sub>θJC</sub> | 25  | 15 | 8.5 | 6 | 3.5 | 3 | °C/W |

## TRW2000 Series

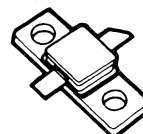
5.2 TO 9 dB  
 1–2.3 GHz  
 1 TO 20 WATTS  
 MICROWAVE  
 POWER TRANSISTORS



GP-13  
 CASE 328F-01, STYLE 2  
 TRW2001, 2003, 2005, 2010



GP-13F  
 CASE 328E-01, STYLE 1  
 TRW2001F, 2003F, 2005F, 2010F



HLP-11  
 CASE 393-01, STYLE 1  
 TRW2015, 2020

**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic                                                                                                                                                                                                                                                                                                                                | Symbol                                                                                      | Min                                    | Typ                        | Max                                    | Unit |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------|----------------------------|----------------------------------------|------|
| <b>OFF CHARACTERISTICS</b>                                                                                                                                                                                                                                                                                                                    |                                                                                             |                                        |                            |                                        |      |
| Collector-Emitter Breakdown Voltage<br>( $I_C = 10\text{ mA}$ , $V_{BE} = 0$ )<br>( $I_C = 20\text{ mA}$ , $V_{BE} = 0$ )<br>( $I_C = 40\text{ mA}$ , $V_{BE} = 0$ )<br>( $I_C = 80\text{ mA}$ , $V_{BE} = 0$ )<br>( $I_C = 120\text{ mA}$ , $V_{BE} = 0$ )<br>( $I_C = 160\text{ mA}$ , $V_{BE} = 0$ )                                       | TRW2001,F<br>TRW2003,F<br>TRW2005,F<br>TRW2010,F<br>TRW2015<br>TRW2020<br><br>$V_{(BR)CES}$ | 50<br>50<br>50<br>50<br>50<br>50       | —<br>—<br>—<br>—<br>—<br>— | —<br>—<br>—<br>—<br>—<br>—             | Vdc  |
| Emitter-Base Breakdown Voltage<br>( $I_E = 0.2\text{ mA}$ , $I_C = 0$ )<br>( $I_E = 0.25\text{ mA}$ , $I_C = 0$ )<br>( $I_E = 0.5\text{ mA}$ , $I_C = 0$ )<br>( $I_E = 1\text{ mA}$ , $I_C = 0$ )<br>( $I_E = 1.5\text{ mA}$ , $I_C = 0$ )<br>( $I_E = 2\text{ mA}$ , $I_C = 0$ )                                                             | TRW2001,F<br>TRW2003,F<br>TRW2005,F<br>TRW2010,F<br>TRW2015<br>TRW2020<br><br>$V_{(BR)EBO}$ | 3.5<br>3.5<br>3.5<br>3.5<br>3.5<br>3.5 | —<br>—<br>—<br>—<br>—<br>— | —<br>—<br>—<br>—<br>—<br>—             | Vdc  |
| Collector Cutoff Current<br>( $V_{CB} = 28\text{ V}$ , $I_E = 0$ )                                                                                                                                                                                                                                                                            | TRW2001,F<br>TRW2003,F<br>TRW2005,F<br>TRW2010,F<br>TRW2015<br>TRW2020<br><br>$I_{CBO1}$    | 0.5<br>0.5<br>0.5<br>—<br>—<br>—       | —<br>—<br>—<br>—<br>—<br>— | —<br>—<br>—<br>0.5<br>1.5<br>2         | mAdc |
| Collector Cutoff Current<br>( $V_{CE} = 45\text{ V}$ , $I_E = 0$ )                                                                                                                                                                                                                                                                            | TRW2001,F<br>TRW2003,F<br>TRW2005,F<br>TRW2010,F<br>TRW2015<br>TRW2020<br><br>$I_{CBO2}$    | 1<br>1<br>2<br>—<br>—<br>—             | —<br>—<br>—<br>—<br>—<br>— | —<br>—<br>—<br>4<br>6<br>8             | mAdc |
| <b>ON CHARACTERISTICS</b>                                                                                                                                                                                                                                                                                                                     |                                                                                             |                                        |                            |                                        |      |
| DC Current Gain<br>( $I_C = 100\text{ mA}$ , $V_{CE} = 5\text{ V}$ )<br>( $I_C = 100\text{ mA}$ , $V_{CE} = 5\text{ V}$ )<br>( $I_C = 200\text{ mA}$ , $V_{CE} = 5\text{ V}$ )<br>( $I_C = 400\text{ mA}$ , $V_{CE} = 5\text{ V}$ )<br>( $I_C = 600\text{ mA}$ , $V_{CE} = 5\text{ V}$ )<br>( $I_C = 800\text{ mA}$ , $V_{CE} = 5\text{ V}$ ) | TRW2001,F<br>TRW2003,F<br>TRW2005,F<br>TRW2010,F<br>TRW2015<br>TRW2020<br><br>$h_{FE}$      | 10<br>10<br>10<br>10<br>10<br>10       | —<br>—<br>—<br>—<br>—<br>— | 120<br>100<br>100<br>100<br>100<br>100 | —    |
| <b>DYNAMIC CHARACTERISTICS</b>                                                                                                                                                                                                                                                                                                                |                                                                                             |                                        |                            |                                        |      |
| Output Capacitance<br>( $V_{CB} = 28\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ )                                                                                                                                                                                                                                                             | TRW2001,F<br>TRW2003,F<br>TRW2005,F<br>TRW2010,F<br>TRW2015<br>TRW2020<br><br>$C_{ob}$      | 4<br>5<br>7<br>—<br>—<br>—             | —<br>—<br>—<br>—<br>—<br>— | —<br>—<br>—<br>12<br>21<br>24          | pF   |

(continued)

[illegible]

## TYPICAL CHARACTERISTICS

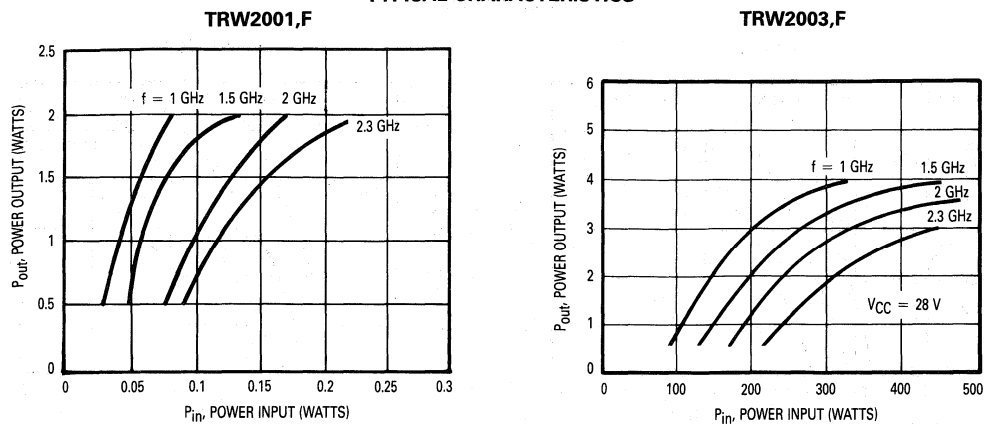


Figure 1. Output Power versus Input Power

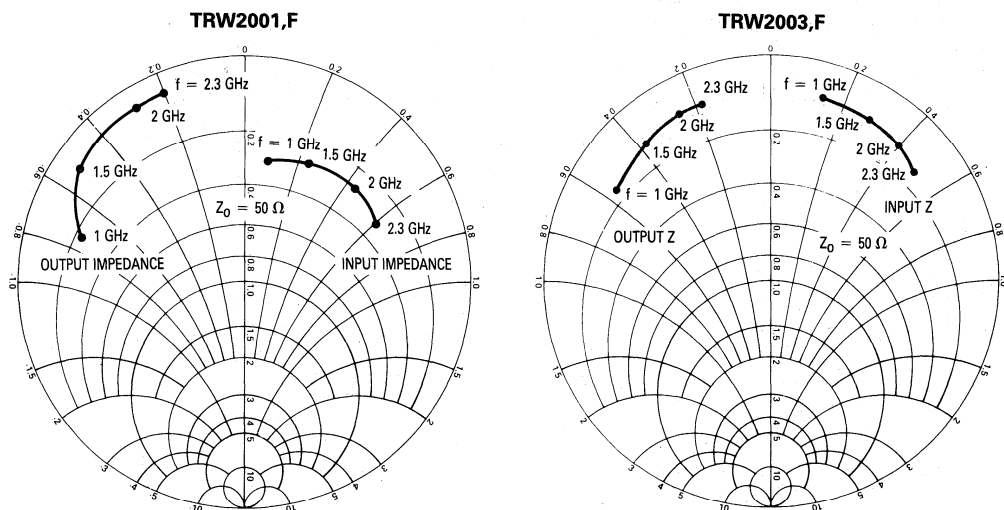
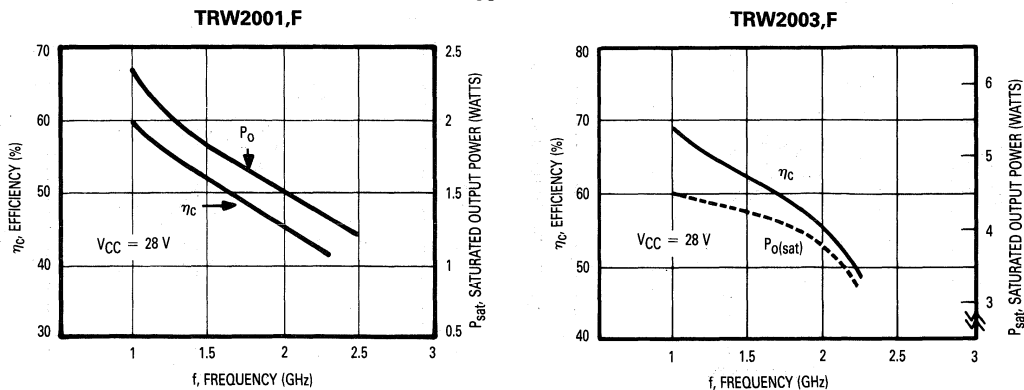
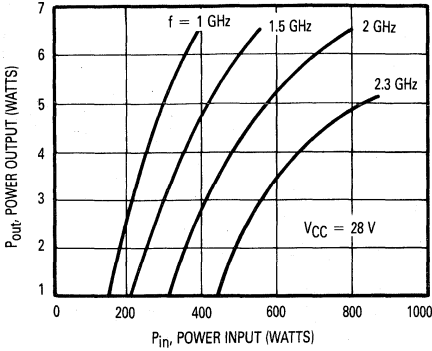
Figure 2. Series Equivalent Input/Output Impedance  
 $V_{CC} = 28$  V

Figure 3. Power Output and Efficiency versus Frequency

TYPICAL CHARACTERISTICS

TRW2005,F



TRW2010,F

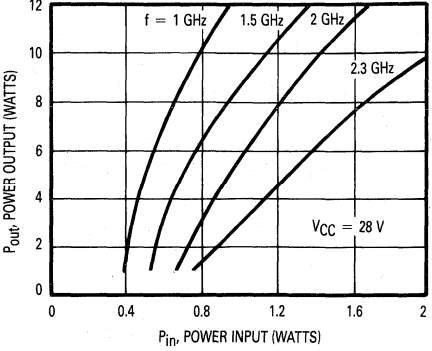
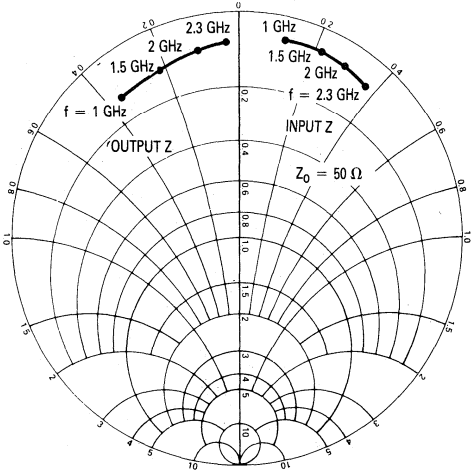


Figure 4. Output Power versus Input Power

TRW2005,F



TRW2010,F

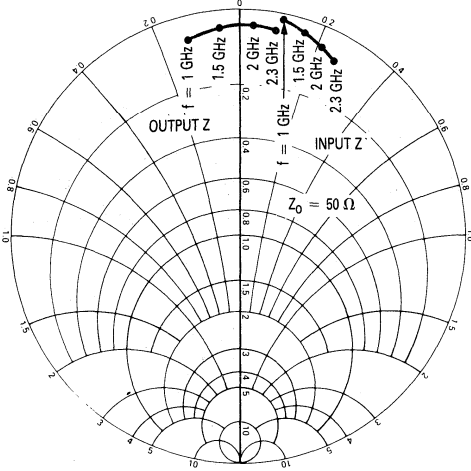
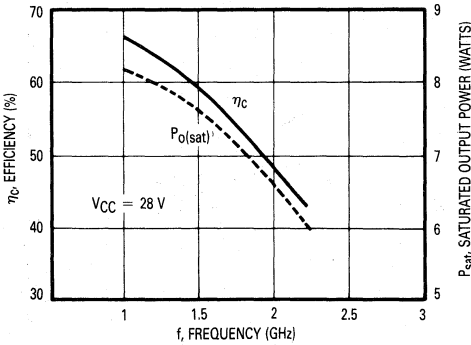


Figure 5. Series Equivalent Input/Output Impedance  
 $V_{CC} = 28\text{ V}$

TRW2005,F



TRW2010,F

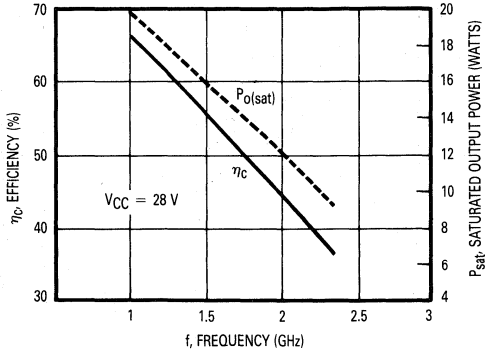


Figure 6. Power Output and Efficiency versus Frequency

TYPICAL CHARACTERISTICS

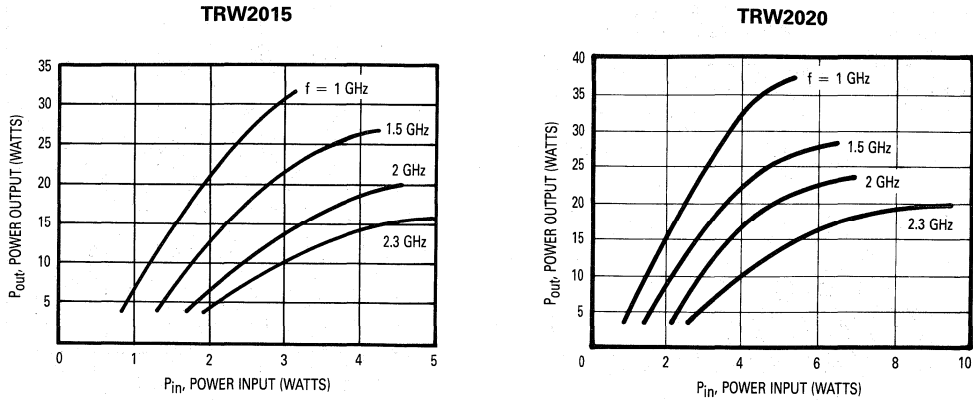


Figure 7. Output Power versus Input Power

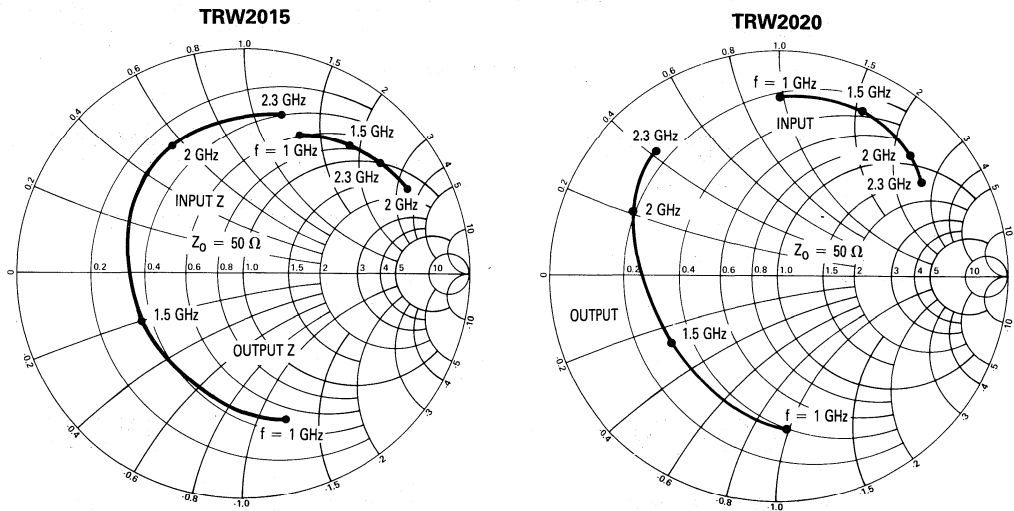


Figure 8. Series Equivalent Input/Output Impedance  
 $V_{CC} = 28 \text{ V}$

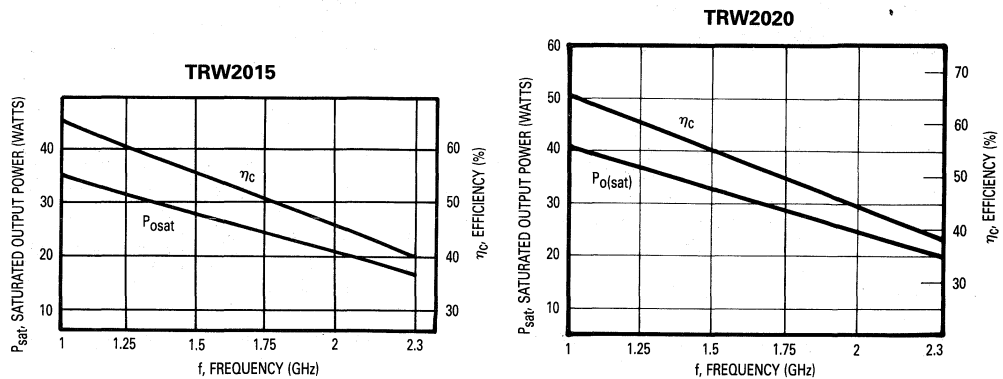


Figure 9. Power Output and Efficiency versus Frequency

The graph shown below displays MTTF in hours x ampere<sup>2</sup> emitter current for each of the "Super 2 GHz" devices. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included on the graph.

## Example for TRW2010

$$\begin{aligned} P_o &= 10 \text{ W} \\ P_{in} &= 2 \text{ W} \\ V_{CC} &= 28 \text{ V} \\ \eta_c &= 40\% \\ T_{FLANGE} &= 70^\circ\text{C} \\ I_C = I_E &= \frac{100 \times P_o}{\eta_c \times V_{CC}} = 0.892 \\ P_{DISS} &= P_{in} + V_{CC} \cdot I_C - P_o = 16.9 \text{ W} \\ T_J &= T_{FLANGE} + \theta_{JC} \times P_{DISS} = 171^\circ\text{C} \\ \text{MTTF} &= \frac{0.065 \times 10^6 \text{ Hrs} \times \text{Amp}^2}{I_C^2} = 81,692 \text{ Hrs} \\ &= 9.32 \text{ Yrs} \end{aligned}$$

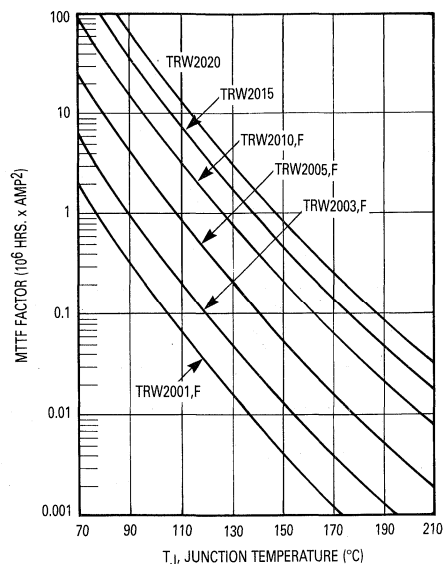


Figure 10. MTTF Factor

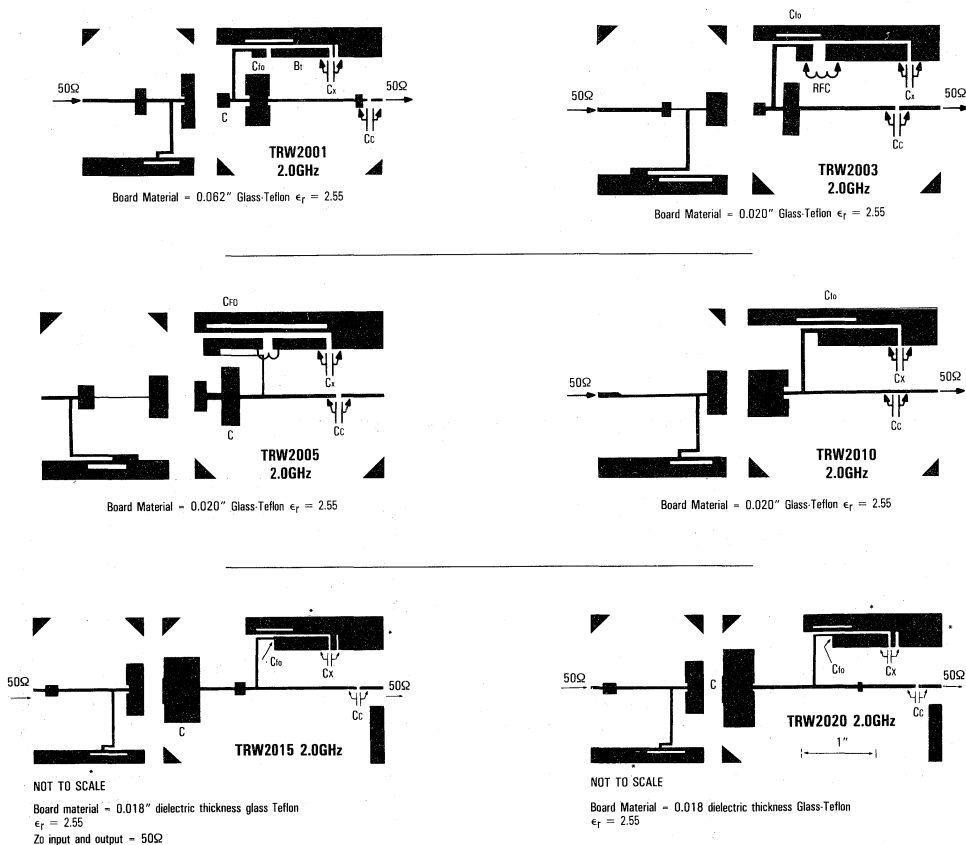


Figure 11. PC Board Layouts

**The RF Line**

**Microwave Power Transistors**

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.5 to 3 GHz frequency range.

- Designed for Class B or C, Common Base Power Amplifiers
- Specified 20 Volt, 2.3 GHz Characteristics:
  - Output Power — 1.5 Watts
  - Power Gain — 8 dB, Min
  - Collector Efficiency — 40% Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Base Voltage         | $V_{CES}$ | 42          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Collector Current — Continuous | $I_C$     | 0.5         | Adc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 25  | °C/W |

**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                             |               |     |   |     |      |
|-----------------------------------------------------------------------------|---------------|-----|---|-----|------|
| Collector-Emitter Breakdown Voltage ( $I_C = 10\text{ mA}$ , $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 42  | — | —   | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 1\text{ mA}$ , $I_C = 0$ )          | $V_{(BR)EBO}$ | 3.5 | — | —   | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 22\text{ V}$ , $I_E = 0$ )             | $I_{CBO1}$    | —   | — | 0.5 | mAdc |
| Collector Cutoff Current ( $V_{CE} = 38\text{ V}$ , $I_E = 0$ )             | $I_{CBO2}$    | —   | — | 1   | mAdc |

**ON CHARACTERISTICS**

|                                                                   |          |    |   |     |   |
|-------------------------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 100\text{ mA}$ , $V_{CE} = 5\text{ V}$ ) | $h_{FE}$ | 10 | — | 120 | — |
|-------------------------------------------------------------------|----------|----|---|-----|---|

**DYNAMIC CHARACTERISTICS**

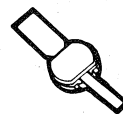
|                                                                                |          |   |   |     |    |
|--------------------------------------------------------------------------------|----------|---|---|-----|----|
| Output Capacitance ( $V_{CB} = 22\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ ) | $C_{ob}$ | — | — | 3.5 | pF |
|--------------------------------------------------------------------------------|----------|---|---|-----|----|

**FUNCTIONAL TESTS**

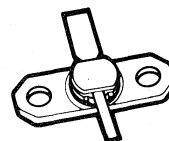
|                                                                                                                                             |          |                                |   |   |    |
|---------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------|---|---|----|
| Common-Base Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 1.5\text{ W}$ , $f = 2.3\text{ GHz}$ )                            | $G_{PB}$ | 8                              | — | — | dB |
| Collector Efficiency ( $V_{CE} = 20\text{ V}$ , $P_{out} = 1.5\text{ W}$ , $f = 2.3\text{ GHz}$ )                                           | $\eta_c$ | 40                             | — | — | %  |
| Load Mismatch<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 1.5\text{ W}$ , $f = 2.3\text{ GHz}$ ,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$   | No Degradation in Output Power |   |   |    |

**TRW2301**  
**TRW2301F**

8 dB  
 1.5–3 GHz  
 1.5 WATTS  
 MICROWAVE  
 POWER  
 TRANSISTORS



GP-13F  
 CASE 328E-01, STYLE 1  
 TRW2301F



GP-13  
 CASE 328F-01, STYLE 2  
 TRW2301



TYPICAL CHARACTERISTICS

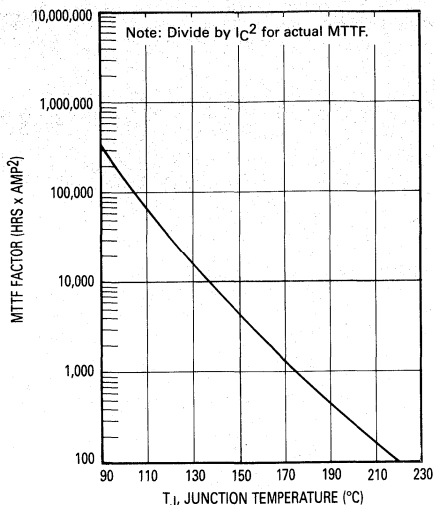


Figure 1. MTTF Factor versus Junction Temperature

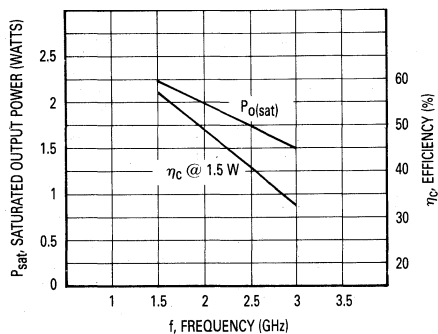


Figure 3.  $P_{sat}$  and Efficiency versus Frequency

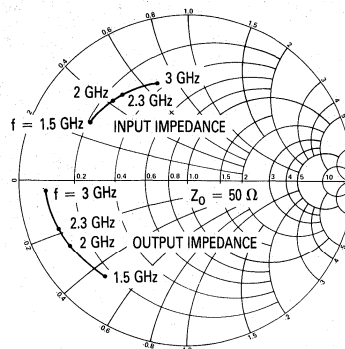


Figure 2. Series Equivalent Input/Output Impedance

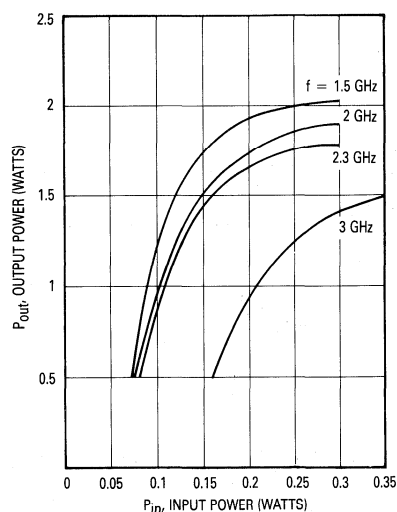
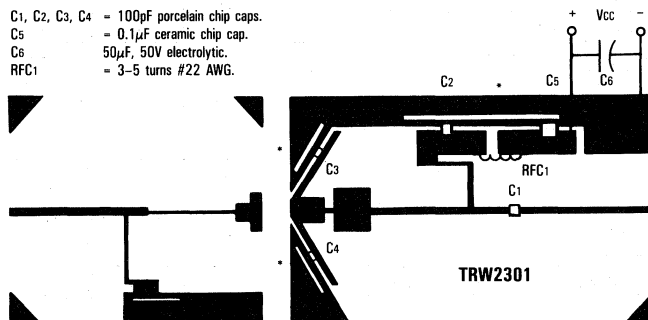


Figure 4. Output Power versus Input Power

C1, C2, C3, C4 = 100pF porcelain chip caps.  
C5 = 0.1μF ceramic chip cap.  
C6 = 50μF, 50V electrolytic.  
RFC1 = 3-5 turns #22 AWG.



\*Ground to backside of board  
Board material: 0.018" dielectric thickness teflon fiberglass.

Figure 5. PC Board Layout (Not to Scale)

## The RF Line

# Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.5 to 3 GHz frequency range.

- Designed for Class B or C, Common Base Power Amplifiers
- Specified 20 Volt, 2.3 GHz Characteristics:
  - Output Power — 4 Watts
  - Power Gain — 8 dB, Min
  - Collector Efficiency — 40% Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Base Voltage         | $V_{CES}$ | 42          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Collector Current — Continuous | $I_C$     | 1.5         | Adc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 17  | °C/W |

### ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                             |               |     |   |      |      |
|-----------------------------------------------------------------------------|---------------|-----|---|------|------|
| Collector-Emitter Breakdown Voltage ( $I_C = 30\text{ mA}$ , $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 42  | — | —    | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 1\text{ mA}$ , $I_C = 0$ )          | $V_{(BR)EBO}$ | 3.5 | — | —    | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 22\text{ V}$ , $I_E = 0$ )             | $I_{CBO1}$    | —   | — | 0.75 | mAdc |
| Collector Cutoff Current ( $V_{CE} = 38\text{ V}$ , $I_E = 0$ )             | $I_{CBO2}$    | —   | — | 3    | mAdc |

### ON CHARACTERISTICS

|                                                                   |          |    |   |     |   |
|-------------------------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 300\text{ mA}$ , $V_{CE} = 5\text{ V}$ ) | $h_{FE}$ | 10 | — | 120 | — |
|-------------------------------------------------------------------|----------|----|---|-----|---|

### DYNAMIC CHARACTERISTICS

|                                                                                |          |   |   |   |    |
|--------------------------------------------------------------------------------|----------|---|---|---|----|
| Output Capacitance ( $V_{CB} = 22\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ ) | $C_{ob}$ | — | — | 7 | pF |
|--------------------------------------------------------------------------------|----------|---|---|---|----|

### FUNCTIONAL TESTS

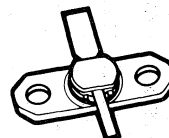
|                                                                                                                                           |          |                                |   |   |    |
|-------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------|---|---|----|
| Common-Base Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 4\text{ W}$ , $f = 2.3\text{ GHz}$ )                            | $G_{PB}$ | 8                              | — | — | dB |
| Collector Efficiency ( $V_{CE} = 20\text{ V}$ , $P_{out} = 4\text{ W}$ , $f = 2.3\text{ GHz}$ )                                           | $\eta_c$ | 40                             | — | — | %  |
| Load Mismatch<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 4\text{ W}$ , $f = 2.3\text{ GHz}$ ,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$   | No Degradation in Output Power |   |   |    |

**TRW2304**  
**TRW2304F**

**8 dB**  
**1.5–3 GHz**  
**4 WATTS**  
**MICROWAVE**  
**POWER**  
**TRANSISTORS**



GP-13F  
CASE 328E-01, STYLE 1  
TRW2304F



GP-13  
CASE 328F-01, STYLE 2  
TRW2304

## TYPICAL CHARACTERISTICS

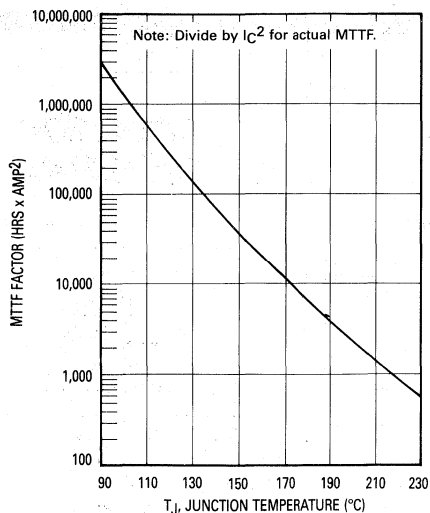


Figure 1. MTTF Factor versus Junction Temperature

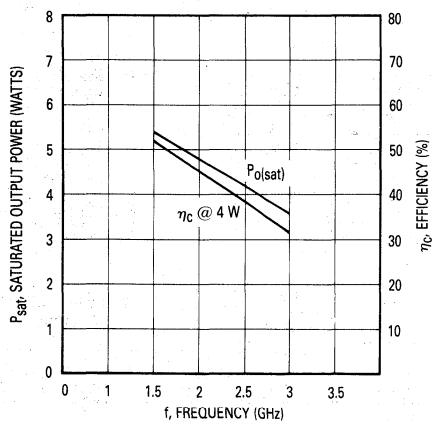
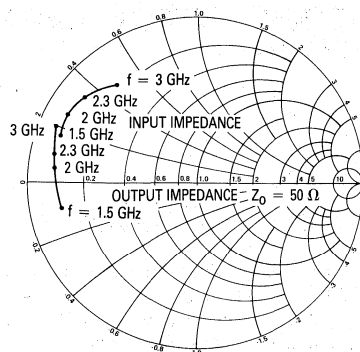
Figure 3.  $P_{sat}$  and Efficiency versus Frequency

Figure 2. Series Equivalent Input/Output Impedance

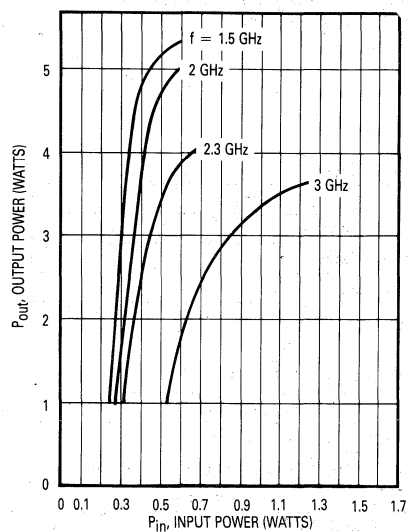
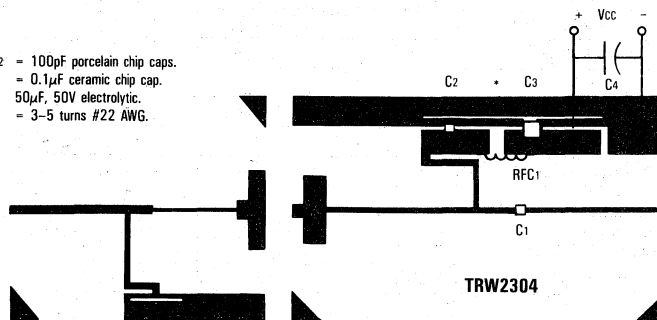


Figure 4. Output Power versus Input Power

C1, C2 = 100pF porcelain chip caps.  
 C3 = 0.1μF ceramic chip cap.  
 C4 = 50μF, 50V electrolytic.  
 RFC1 = 3-5 turns #22 AWG.



\*Ground to backside of board  
 Board material: 0.018" dielectric thickness teflon fiberglass.

Figure 5. PC Board Layout (Not to Scale)

**The RF Line**

**Microwave Power Transistors**

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.5 to 3 GHz frequency range.

- Designed for Class B or C, Common Base Power Amplifiers
- Specified 20 Volt, 2.3 GHz Characteristics:
  - Output Power — 7 Watts
  - Power Gain — 8 dB, Min
  - Collector Efficiency — 40% Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Base Voltage         | $V_{CES}$ | 42          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Collector Current — Continuous | $I_C$     | 2.5         | Adc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 8.5 | °C/W |

**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                             |               |     |   |      |      |
|-----------------------------------------------------------------------------|---------------|-----|---|------|------|
| Collector-Emitter Breakdown Voltage ( $I_C = 50\text{ mA}$ , $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 42  | — | —    | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 1\text{ mA}$ , $I_C = 0$ )          | $V_{(BR)EBO}$ | 3.5 | — | —    | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 22\text{ V}$ , $I_E = 0$ )             | $I_{CBO1}$    | —   | — | 1.25 | mAdc |
| Collector Cutoff Current ( $V_{CE} = 38\text{ V}$ , $I_E = 0$ )             | $I_{CBO2}$    | —   | — | 5    | mAdc |

**ON CHARACTERISTICS**

|                                                                   |          |    |   |     |   |
|-------------------------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 500\text{ mA}$ , $V_{CE} = 5\text{ V}$ ) | $h_{FE}$ | 10 | — | 120 | — |
|-------------------------------------------------------------------|----------|----|---|-----|---|

**DYNAMIC CHARACTERISTICS**

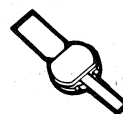
|                                                                                |          |   |   |    |    |
|--------------------------------------------------------------------------------|----------|---|---|----|----|
| Output Capacitance ( $V_{CB} = 22\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ ) | $C_{ob}$ | — | — | 10 | pF |
|--------------------------------------------------------------------------------|----------|---|---|----|----|

**FUNCTIONAL TESTS**

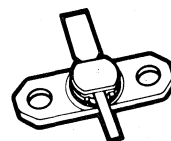
|                                                                                                                                           |          |                                |   |   |    |
|-------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------|---|---|----|
| Common-Base Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 7\text{ W}$ , $f = 2.3\text{ GHz}$ )                            | $G_{PB}$ | 8                              | — | — | dB |
| Collector Efficiency ( $V_{CE} = 20\text{ V}$ , $P_{out} = 7\text{ W}$ , $f = 2.3\text{ GHz}$ )                                           | $\eta_c$ | 40                             | — | — | %  |
| Load Mismatch<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 7\text{ W}$ , $f = 2.3\text{ GHz}$ ,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$   | No Degradation in Output Power |   |   |    |

**TRW2307**  
**TRW2307F**

**8 dB**  
**1.5–3 GHz**  
**7 WATTS**  
**MICROWAVE**  
**POWER**  
**TRANSISTORS**



**GP-13F**  
**CASE 328E-01, STYLE 1**  
**TRW2307F**



**GP-13**  
**CASE 328F-01, STYLE 2**  
**TRW2307**

TYPICAL CHARACTERISTICS

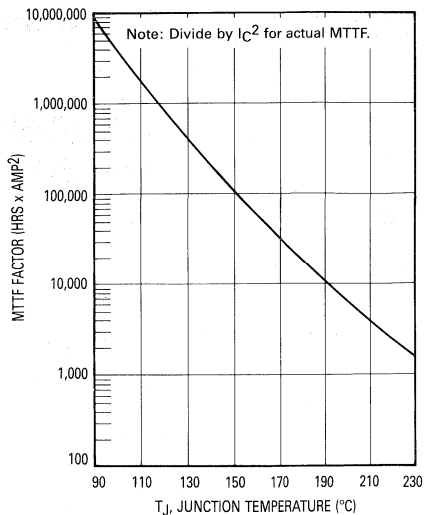


Figure 1. MTF Factor versus Junction Temperature

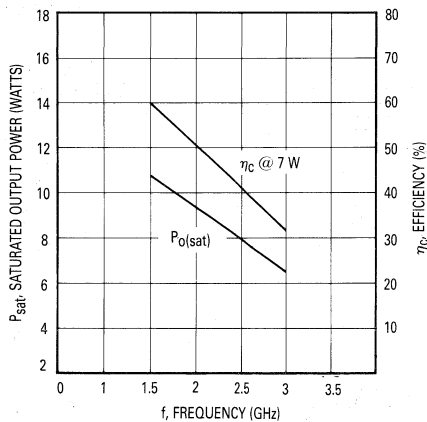


Figure 3.  $P_{sat}$  and Efficiency versus Frequency

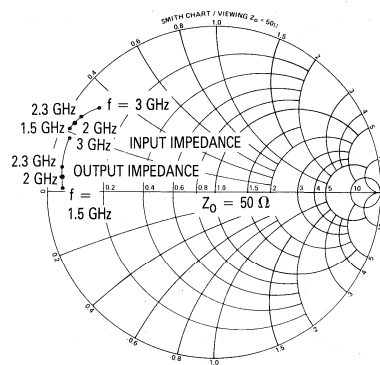


Figure 2. Series Equivalent Input/Output Impedance

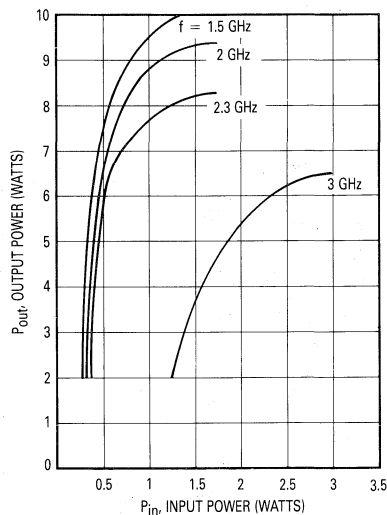
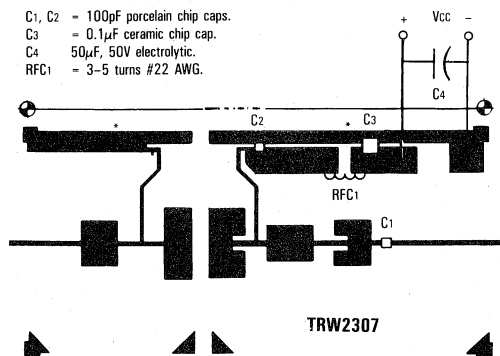


Figure 4. Output Power versus Input Power



\*Ground to backside of board  
 Board material: 0.018" dielectric thickness teflon fiberglass.

Figure 5. PC Board Layout (Not to Scale)

## The RF Line

# Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.5 to 3 GHz frequency range.

- Designed for Class B or C, Common Base Linear Power Amplifiers
- Specified 28 Volt, 3 GHz Characteristics:
  - Output Power — 1 to 5 Watts
  - Power Gain — 5 to 7 dB Min
  - Collector Efficiency — 30% Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

## TRW3000 Series

**5 TO 7 dB**  
**1.5-3 GHz**  
**1 TO 5 WATTS**  
**MICROWAVE**  
**POWER**  
**TRANSISTORS**

### MAXIMUM RATINGS

| Rating                         | Symbol    | 3001,F      | 3003,F | 3005,F |     |
|--------------------------------|-----------|-------------|--------|--------|-----|
| Collector-Base Voltage         | $V_{CBO}$ | 45          |        |        | Vdc |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         |        |        | Vdc |
| Operating Junction Temperature | $T_J$     | 200         |        |        | °C  |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 |        |        | °C  |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max |    |     | Unit |
|--------------------------------------|-----------------|-----|----|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 35  | 17 | 8.5 | °C/W |

### ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

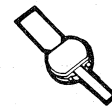
### OFF CHARACTERISTICS

|                                                                                                                                                                      |                               |               |                |             |                     |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|---------------|----------------|-------------|---------------------|------|
| Collector-Emitter Breakdown Voltage<br>( $I_C = 10\text{ mA}$ , $V_{BE} = 0$ )<br>( $I_C = 30\text{ mA}$ , $V_{BE} = 0$ )<br>( $I_C = 50\text{ mA}$ , $V_{BE} = 0$ ) | TRW3001,F<br>3003,F<br>3005,F | $V_{(BR)CES}$ | 50<br>50<br>50 | —<br>—<br>— | —<br>—<br>—         | Vdc  |
| Collector-Base Breakdown Voltage<br>( $I_C = 1\text{ mA}$ , $I_E = 0$ )<br>( $I_C = 3\text{ mA}$ , $I_E = 0$ )<br>( $I_C = 5\text{ mA}$ , $I_E = 0$ )                | TRW3001,F<br>3003,F<br>3005,F | $V_{(BR)CBO}$ | 45<br>45<br>45 | —<br>—<br>— | —<br>—<br>—         | Vdc  |
| Emitter-Base Breakdown Voltage<br>( $I_E = 1\text{ mA}$ , $I_C = 0$ )                                                                                                |                               | $V_{(BR)EBO}$ | 3.5            | —           | —                   | Vdc  |
| Collector Cutoff Current<br>( $V_{CB} = 28\text{ V}$ , $I_E = 0$ )                                                                                                   | TRW3001,F<br>3003,F<br>3005,F | $I_{CBO}$     | —<br>—<br>—    | —<br>—<br>— | 0.5<br>0.75<br>1.25 | mAdc |

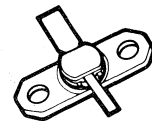
### ON CHARACTERISTICS

|                                                                                                                                                                                |                               |          |                |             |                   |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------|----------------|-------------|-------------------|---|
| DC Current Gain<br>( $I_C = 100\text{ mA}$ , $V_{CE} = 5\text{ V}$ )<br>( $I_C = 300\text{ mA}$ , $V_{CE} = 5\text{ V}$ )<br>( $I_C = 500\text{ mA}$ , $V_{CE} = 5\text{ V}$ ) | TRW3001,F<br>3003,F<br>3005,F | $h_{FE}$ | 10<br>10<br>10 | —<br>—<br>— | 120<br>120<br>120 | — |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------|----------------|-------------|-------------------|---|

(continued)



GP-13F  
CASE 328E-01, STYLE 1  
TRW3001F, 3003F, 3005F



GP-13  
CASE 328F-01, STYLE 2  
TRW3001, 3003, 3005

# TRW3000 Series

ELECTRICAL CHARACTERISTICS — continued ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic                                                                                                                                                                                                                                                       |                               | Symbol   | Min                               | Typ               | Max          | Unit |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------|-----------------------------------|-------------------|--------------|------|
| DYNAMIC CHARACTERISTICS                                                                                                                                                                                                                                              |                               |          |                                   |                   |              |      |
| Output Capacitance<br>( $V_{CB} = 28\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ )                                                                                                                                                                                    | TRW3001,F<br>3003,F<br>3005,F | $C_{ob}$ | —<br>—<br>—                       | 3.5<br>5.7<br>8.4 | 4<br>7<br>10 | pF   |
| FUNCTIONAL TESTS                                                                                                                                                                                                                                                     |                               |          |                                   |                   |              |      |
| Common-Base Amplifier Power Gain<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 1\text{ W}$ , $f = 3\text{ GHz}$ )<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 3\text{ W}$ , $f = 3\text{ GHz}$ )<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 5\text{ W}$ , $f = 3\text{ GHz}$ ) | TRW3001,F<br>3003,F<br>3005,F | $G_{PB}$ | 7<br>6<br>5                       | —<br>—<br>—       | —<br>—<br>—  | dB   |
| Collector Efficiency<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 1\text{ W}$ , $f = 3\text{ GHz}$ )<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 3\text{ W}$ , $f = 3\text{ GHz}$ )<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 5\text{ W}$ , $f = 3\text{ GHz}$ )             | TRW3001,F<br>3003,F<br>3005,F | $\eta_c$ | 30<br>30<br>30                    | —<br>—<br>—       | —<br>—<br>—  | %    |
| Load Mismatch<br>( $V_{CE} = 28\text{ V}$ , $P_{out} = 1\text{ W}$ , $f = 3\text{ GHz}$ ,<br>$P_{out} = 3\text{ W}$<br>$P_{out} = 5\text{ W}$<br>Load VSWR = $\infty:1$ , All Phase Angles)                                                                          | TRW3001,F<br>3003,F<br>3005,F | $\psi$   | No Degradation in<br>Output Power |                   |              |      |

## TRW3001,F TYPICAL CHARACTERISTICS

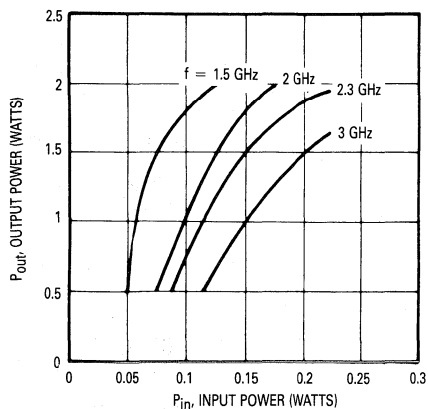


Figure 1. Output Power versus Input Power

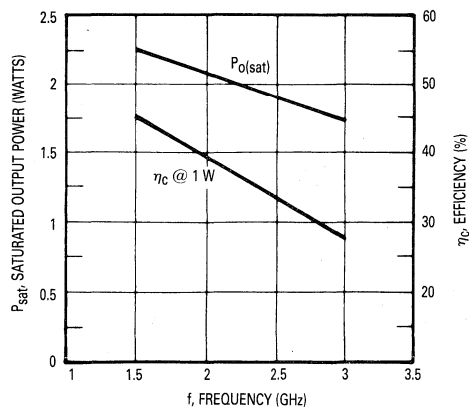


Figure 2.  $P_{sat}$  and  $\eta$  versus Frequency

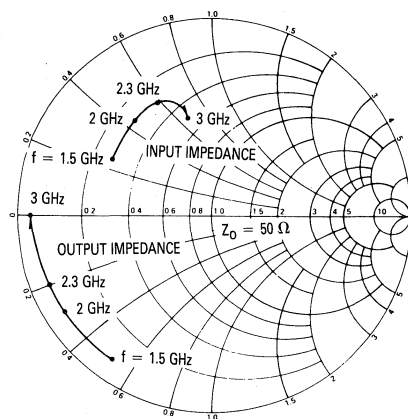


Figure 3. Series Equivalent Input/Output Impedance

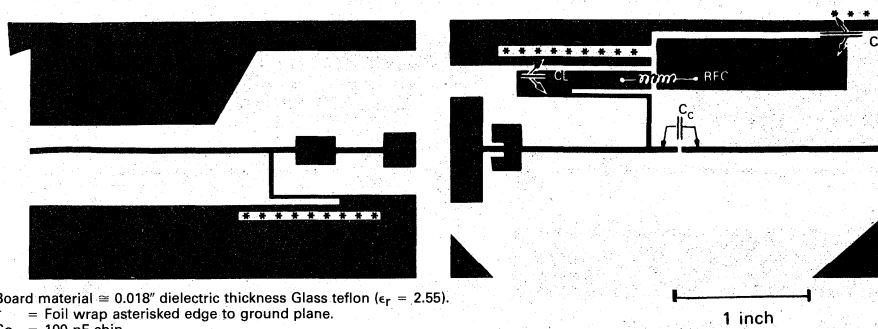


Figure 4. PC Board Layout  
(Not to Scale)

TRW3003,F  
TYPICAL CHARACTERISTICS

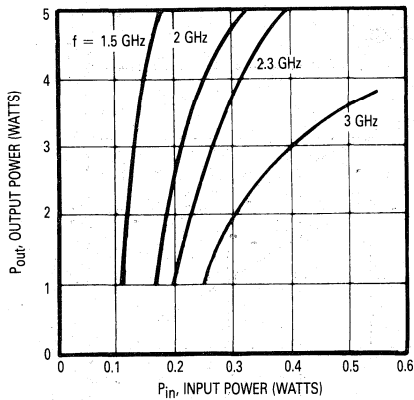


Figure 5. Output Power versus Input Power

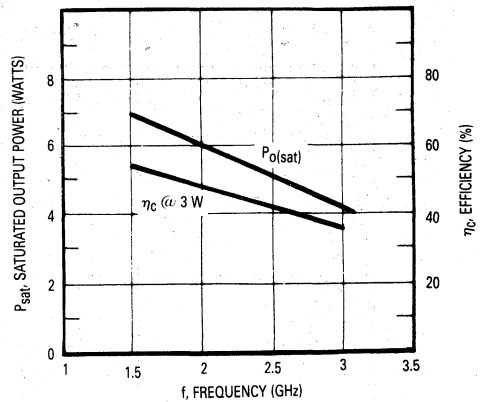


Figure 6.  $P_{sat}$  and  $\eta$  versus Frequency

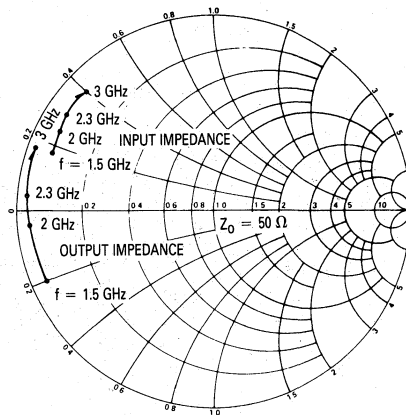


Figure 7. Series Equivalent Input/Output Impedance



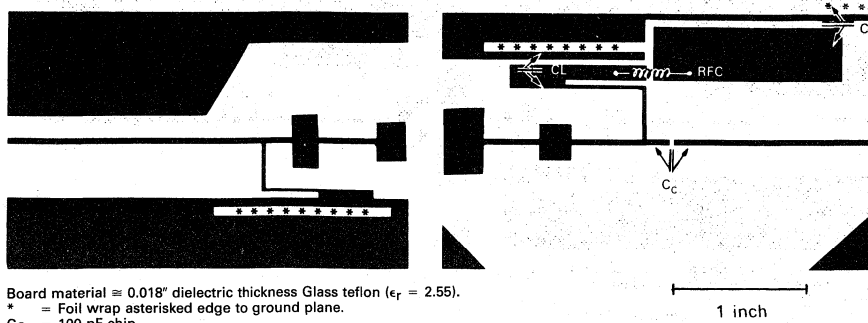


Figure 8. PC Board Layout  
(Not to Scale)

TRW3005,F  
TYPICAL CHARACTERISTICS

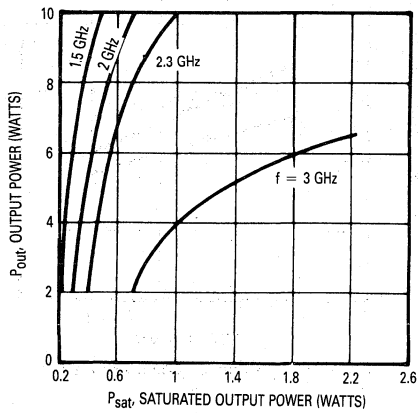


Figure 9. Output Power versus Input Power

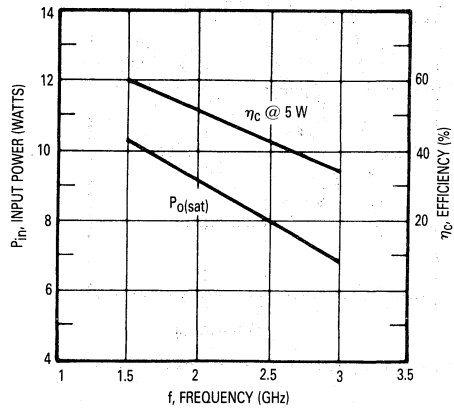


Figure 10.  $P_{sat}$  and  $\eta$  versus Frequency

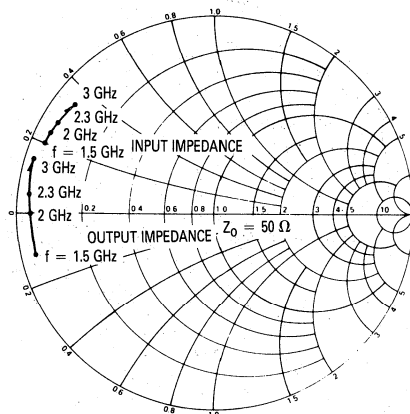
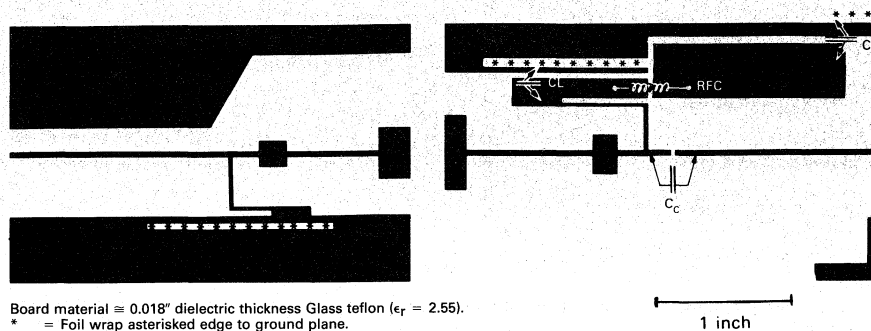


Figure 11. Series Equivalent Input/Output Impedance



Board material = 0.018" dielectric thickness Glass teflon ( $\epsilon_r = 2.55$ ).  
 \* = Foil wrap asterisked edge to ground plane.  
 Cc = 100 pF chip.  
 CX = 100 pF chip capacitor and 10  $\mu$ F electrolytic.  
 CL = 100 pF chip capacitor. The capacitor position can be tuned.  
 RFC = 8 turns #28 AWG, 0.010 dia.

Figure 12. PC Board Layout  
(Not to Scale)

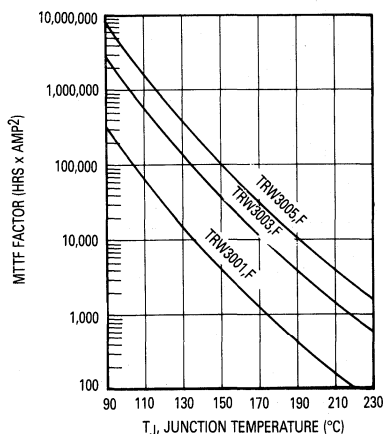


Figure 13. MTTF Factor versus Junction Temperature

**MTTF Factor**  
**(Normalized to 1 ampere<sup>2</sup> Continuous Duty)**  
 The graph shown displays MTTF in hours x ampere<sup>2</sup> emitter current for each of the 3 GHz devices. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  to the theoretical prediction for metal failure. **CAUTION** — A calculation is required to obtain actual metal life. Sample MTTF calculations based on operating conditions are shown below.

Junction Temperature — °C

To calculate metal lifetime under any set of conditions, obtain actual data or estimate from typical performance curves. Solve for  $T_J$  (°C):

$$(1) T_J = \theta_{JF} \left( \frac{P_{out} \times 100}{\eta_c \%} + P_{in} - P_{out} \right) + T_{FLANGE}$$

Enter graph of MTF factor versus  $T_J$ . Obtain MTF factor. Calculate metal life by:

$$(2) \text{Metal Life in Hours} = \frac{\text{MTF Factor}}{I_C^2 (\text{Amps})}$$

## The RF Line

# Microwave Linear Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 2 GHz frequency range.

- Designed for Class A, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  - Output Power — 1.5 Watts
  - Power Gain — 5 to 6 dB, Min
- Variety of Package Options, Including Hermetic
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 24          | Vdc  |
| Collector-Base Voltage         | $V_{CES}$ | 50          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 16  | °C/W |

### ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                        |               |      |   |       |      |
|------------------------------------------------------------------------|---------------|------|---|-------|------|
| Collector-Emitter Breakdown Voltage<br>( $I_C = 20$ mA, $I_B = 0$ )    | $V_{(BR)CEO}$ | 24   | — | —     | Vdc  |
| Collector-Emitter Breakdown Voltage<br>( $I_C = 20$ mA, $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 50   | — | —     | Vdc  |
| Collector-Base Breakdown Voltage<br>( $I_C = 1$ mA, $I_E = 0$ )        | $V_{(BR)CBO}$ | 45 V | — | —     | Vdc  |
| Emitter-Base Breakdown Voltage<br>( $I_E = 0.25$ mA, $I_C = 0$ )       | $V_{(BR)EBO}$ | 3.5  | — | —     | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 28$ V, $I_E = 0$ )                | $I_{CBO}$     | —    | — | 0.125 | mAdc |

### ON CHARACTERISTICS

|                                                   |          |    |   |     |   |
|---------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 100$ mA, $V_{CE} = 5$ V) | $h_{FE}$ | 20 | — | 120 | — |
|---------------------------------------------------|----------|----|---|-----|---|

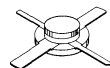
### DYNAMIC CHARACTERISTICS

|                                                                   |          |   |   |   |    |
|-------------------------------------------------------------------|----------|---|---|---|----|
| Output Capacitance<br>( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | — | 5 | pF |
|-------------------------------------------------------------------|----------|---|---|---|----|

(continued)

## TRW52001 Series

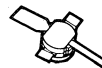
6 dB  
 1 TO 2 GHz  
 1.5 WATTS  
 MICROWAVE  
 LINEAR POWER  
 TRANSISTORS



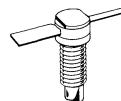
TW-200  
 CASE 400-01, STYLE 1  
 TRW52001



GP-13F  
 CASE 328E-01, STYLE 2  
 TRW52101



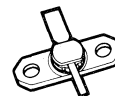
GP-14S  
 CASE 401A-01, STYLE 1  
 TRW52201



GP-13S  
 CASE 328G-01, STYLE 1  
 TRW52401



GP-14  
 CASE 401-01, STYLE 1  
 TRW52501



GP-13  
 CASE 328F-01, STYLE 1  
 TRW52601

## ELECTRICAL CHARACTERISTICS — continued

| Characteristic                                                                                                                                                    | Symbol                                  | Min                               | Typ    | Max        | Unit |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------------|--------|------------|------|
| <b>FUNCTIONAL TESTS</b>                                                                                                                                           |                                         |                                   |        |            |      |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 1.5\text{ W}$ , $f = 2\text{ GHz}$ , $I_E = 220\text{ mA}$ )                         | TRW52001<br>TRW52101<br>TRW52601<br>GPE | 6                                 | —      | —          | dB   |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 1.5\text{ W}$ , $f = 2\text{ GHz}$ , $I_E = 220\text{ mA}$ )                         | TRW52201<br>TRW52401<br>TRW52501<br>GPE | 5                                 | —      | —          | dB   |
| Load Mismatch<br>( $V_{CE} = 20\text{ V}$ , $I_E = 220\text{ mA}$ , $P_{out} = 1.5\text{ W}$ , $f = 2\text{ GHz}$ ,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$                                  | No Degradation in<br>Output Power |        |            |      |
| Cutoff Frequency (Basic cell design)                                                                                                                              | $f_T$                                   | —                                 | 2.7    | —          | GHz  |
| Gain Linearity<br>( $V_{CE} = 20\text{ V}$ , $I_E = 220\text{ mA}$ , $f = 2\text{ GHz}$ , $P_{O1} = 1.5\text{ W}$ , $P_{O2} = 1.5\text{ mW}$ )                    | LG                                      | —<br>—                            | —<br>— | −0.2<br>+1 | dB   |
| Intermodulation Distortion, 3rd Order<br>( $V_{CE} = 20\text{ V}$ , $I_E = 220\text{ mA}$ , $P_O$ (PEP) = 1.5 W,<br>Tones at 2.05 GHz and 2.1 GHz)                | IMD                                     | —                                 | −30    | —          | dB   |

## TYPICAL CHARACTERISTICS

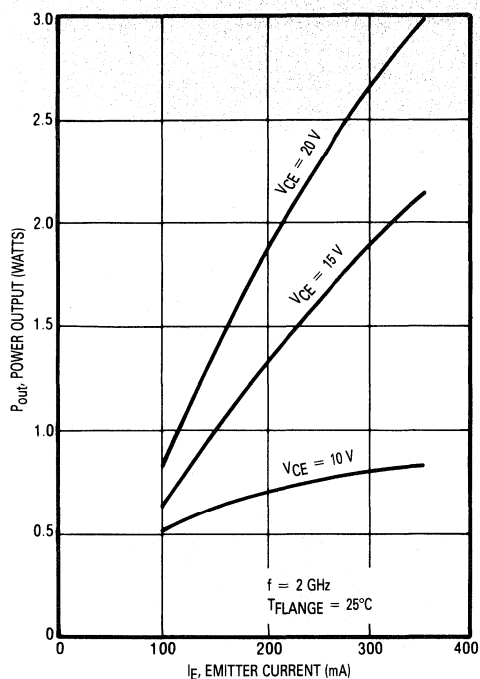


Figure 1. 1 dB Compression Point versus Emitter Current

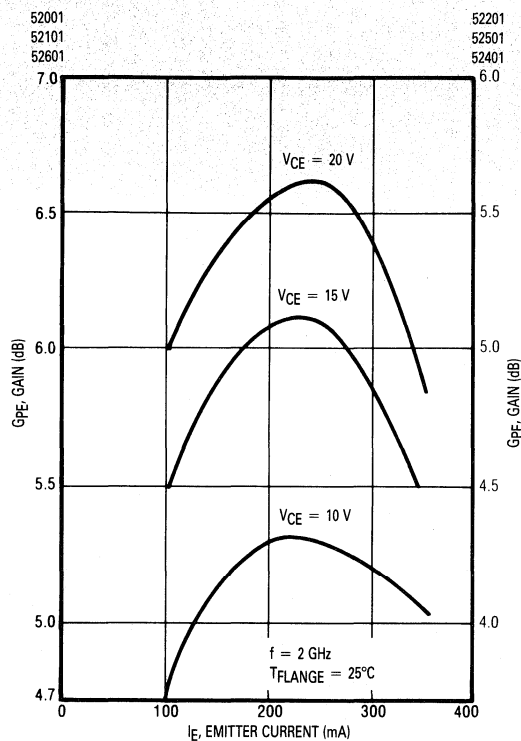


Figure 2. Gain versus Emitter Current

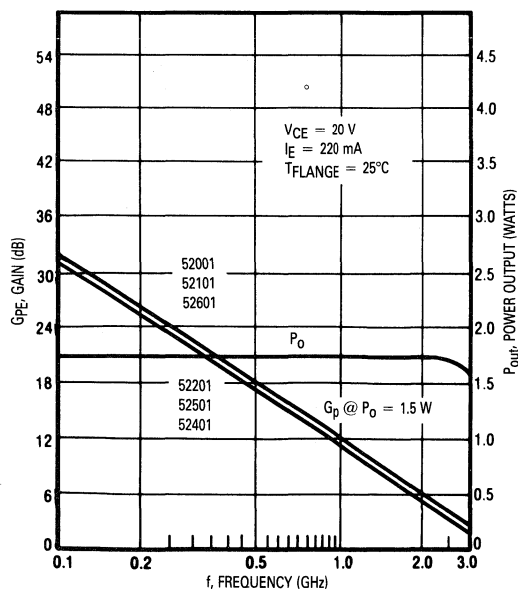


Figure 3. Gain and 1 dB Compressed Power versus Frequency

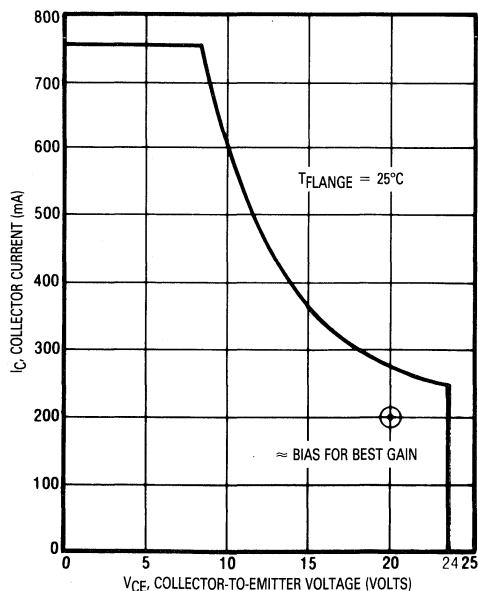


Figure 4. Safe Operating Area

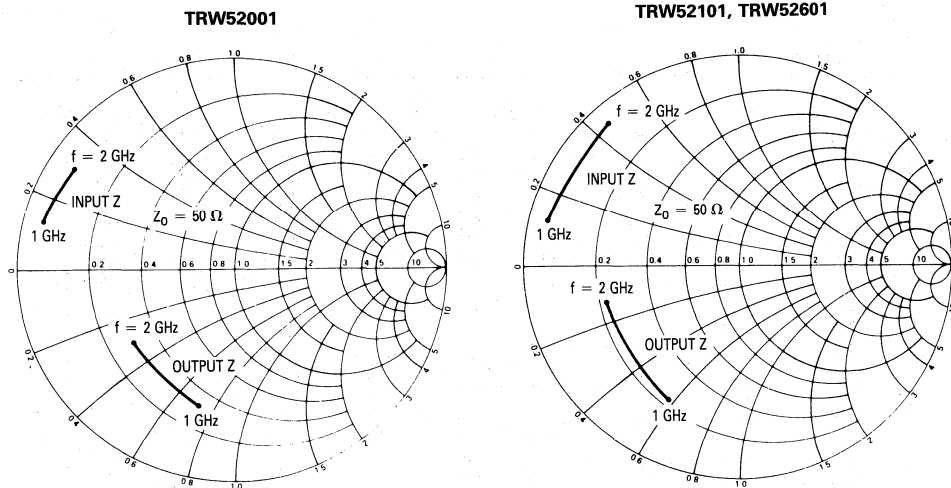
## TRW52001

| V <sub>CE</sub> = 20V |       |       |        |      |       |      |        |        |
|-----------------------|-------|-------|--------|------|-------|------|--------|--------|
| Frequency (MHz)       | S11   |       | S12    |      | S21   |      | S22    |        |
|                       | dB    | Ang   | dB     | Ang  | dB    | Ang  | dB     | Ang    |
| 400                   | -1.38 | 179.2 | -28.81 | 43.5 | 12.56 | 82.7 | -13.06 | -139.4 |
| 500                   | -1.39 | 176.1 | -27.87 | 47.9 | 10.72 | 77.5 | -12.75 | -142.3 |
| 600                   | -1.43 | 173.1 | -26.93 | 52.2 | 9.30  | 74.1 | -12.33 | -142.9 |
| 700                   | -1.41 | 170.2 | -26.17 | 55.1 | 8.02  | 71.2 | -12.00 | -142.8 |
| 800                   | -1.32 | 167.4 | -25.30 | 58.2 | 6.88  | 68.7 | -11.75 | -143.2 |
| 900                   | -1.25 | 165.0 | -24.47 | 59.6 | 5.90  | 65.6 | -11.50 | -144.7 |
| 1000                  | -1.17 | 162.8 | -23.78 | 62.3 | 4.98  | 62.9 | -11.13 | -146.7 |
| 1100                  | -1.13 | 160.2 | -23.07 | 64.4 | 4.10  | 60.2 | -10.57 | -150.3 |
| 1200                  | -1.11 | 158.8 | -22.35 | 67.0 | 3.32  | 58.2 | -10.16 | -152.4 |
| 1300                  | -1.02 | 156.9 | -21.91 | 67.5 | 2.42  | 55.0 | -9.50  | -154.7 |
| 1400                  | -1.08 | 155.5 | -21.61 | 78.7 | 1.69  | 51.2 | -9.01  | -155.7 |
| 1500                  | -1.22 | 153.8 | -20.96 | 70.7 | 1.18  | 47.8 | -8.51  | -156.4 |
| 1600                  | -1.31 | 151.5 | -20.19 | 69.8 | 0.70  | 44.4 | -7.98  | -157.0 |
| 1700                  | -1.37 | 148.5 | -19.89 | 69.9 | 0.19  | 41.0 | -7.80  | -156.9 |
| 1800                  | -1.33 | 145.8 | -19.37 | 70.6 | -0.14 | 38.7 | -7.34  | -157.8 |
| 1900                  | -1.32 | 143.0 | -18.67 | 70.9 | -0.42 | 36.6 | -7.11  | -159.5 |
| 2000                  | -1.24 | 139.9 | -18.19 | 69.6 | -0.70 | 34.6 | -6.84  | -161.2 |
| 2100                  | -0.82 | 135.3 | -17.87 | 71.9 | -0.78 | 34.5 | -6.55  | -162.4 |
| 2200                  | -0.59 | 133.5 | -17.27 | 73.2 | -1.18 | 34.0 | -6.31  | -164.7 |
| 2300                  | -0.46 | 132.3 | -16.87 | 73.2 | -1.78 | 32.8 | -5.99  | -166.7 |
| 2400                  | -0.43 | 131.3 | -16.66 | 72.3 | -2.32 | 31.0 | -5.70  | -168.4 |
| 2500                  | -0.50 | 130.0 | -16.22 | 72.1 | -2.75 | 29.6 | -5.39  | -170.1 |
| 2600                  | -0.66 | 128.0 | -15.80 | 71.6 | -3.28 | 27.2 | -5.09  | -171.1 |
| 2700                  | -0.76 | 125.5 | -15.46 | 70.4 | -3.80 | 25.1 | -4.89  | -172.4 |
| 2800                  | -0.87 | 123.5 | -15.17 | 69.6 | -4.08 | 23.2 | -4.74  | -173.6 |
| 2900                  | -1.09 | 120.4 | -14.71 | 68.1 | -4.25 | 21.4 | -4.62  | -175.3 |
| 3000                  | -1.20 | 116.4 | -14.43 | 67.8 | -4.49 | 18.4 | -4.51  | -176.9 |

## TRW52101/601

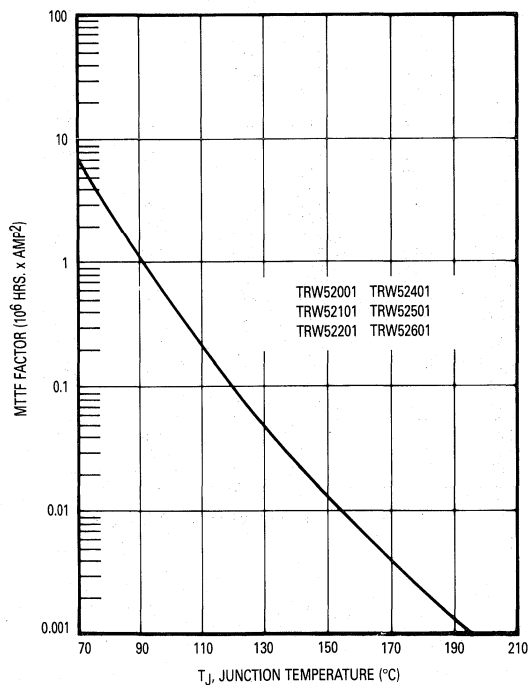
| V <sub>CE</sub> = 20V<br>I <sub>c</sub> = 220mA |       |       |        |       |       |       |       |        |
|-------------------------------------------------|-------|-------|--------|-------|-------|-------|-------|--------|
| Frequency (MHz)                                 | S11   |       | S12    |       | S21   |       | S22   |        |
|                                                 | dB    | Ang   | dB     | Ang   | dB    | Ang   | dB    | Ang    |
| 400                                             | -1.50 | 176.8 | -27.65 | 23.4  | 13.07 | 74.0  | -9.69 | -145.0 |
| 500                                             | -1.44 | 171.6 | -27.36 | 24.1  | 11.25 | 67.3  | -9.48 | -148.6 |
| 600                                             | -1.35 | 168.4 | -26.75 | 25.7  | 9.52  | 60.8  | -9.15 | -152.1 |
| 700                                             | -1.71 | 165.8 | -26.13 | 27.1  | 7.95  | 53.0  | -8.88 | -154.0 |
| 800                                             | -1.99 | 159.6 | -25.62 | 27.8  | 6.88  | 45.3  | -8.44 | -155.6 |
| 900                                             | -1.53 | 155.8 | -25.06 | 29.1  | 5.97  | 39.8  | -8.10 | -157.5 |
| 1000                                            | -1.58 | 152.1 | -24.46 | 29.2  | 5.09  | 34.8  | -7.74 | -159.3 |
| 1100                                            | -1.57 | 148.5 | -23.90 | 28.9  | 4.23  | 28.5  | -7.17 | -161.6 |
| 1200                                            | -1.56 | 145.0 | -23.28 | 28.2  | 3.52  | 22.9  | -6.81 | -164.3 |
| 1300                                            | -1.56 | 141.8 | -22.75 | 27.8  | 2.90  | 17.5  | -6.41 | -165.7 |
| 1400                                            | -1.56 | 138.5 | -22.27 | 27.2  | 2.05  | 12.3  | -6.07 | -169.3 |
| 1500                                            | -1.67 | 135.9 | -21.82 | 25.2  | 1.39  | 6.7   | -5.76 | -171.5 |
| 1600                                            | -1.61 | 132.1 | -21.30 | 23.8  | 0.85  | 0.6   | -5.29 | -175.2 |
| 1700                                            | -1.61 | 128.9 | -20.92 | 24.0  | 0.27  | -2.7  | -5.11 | -177.6 |
| 1800                                            | -1.65 | 125.7 | -20.36 | 21.2  | -0.27 | -9.3  | -4.73 | -179.7 |
| 1900                                            | -1.64 | 122.4 | -20.08 | 19.5  | -0.66 | -14.4 | -4.75 | -175.8 |
| 2000                                            | -1.64 | 119.2 | -19.33 | 20.5  | -1.19 | -16.1 | -4.50 | -175.5 |
| 2100                                            | -1.69 | 116.3 | -20.37 | 9.5   | -1.69 | -24.3 | -4.01 | -169.8 |
| 2200                                            | -1.74 | 113.1 | -19.96 | 7.4   | -2.06 | -29.0 | -3.94 | -167.3 |
| 2300                                            | -1.77 | 109.8 | -19.57 | 5.4   | -2.39 | -32.4 | -3.66 | -164.9 |
| 2400                                            | -1.81 | 106.3 | -19.31 | 4.5   | -2.90 | -36.7 | -3.62 | -162.3 |
| 2500                                            | -1.86 | 102.9 | -18.83 | 0.5   | -3.15 | -42.1 | -3.38 | -160.1 |
| 2600                                            | -1.93 | 99.3  | -18.42 | -1.6  | -3.38 | -45.6 | -3.22 | -156.5 |
| 2700                                            | -2.00 | 95.3  | -18.02 | -2.0  | -3.78 | -49.4 | -3.14 | -154.5 |
| 2800                                            | -2.07 | 91.6  | -17.73 | -6.4  | -4.09 | -54.5 | -2.94 | -152.0 |
| 2900                                            | -2.18 | 87.1  | -17.13 | -9.2  | -4.27 | -59.3 | -2.83 | -149.3 |
| 3000                                            | -2.04 | 83.1  | -16.83 | -11.2 | -4.39 | -62.5 | -2.67 | -146.8 |

Figure 5. Common Emitter S-Parameters



**Figure 6. Series Equivalent Input/Output Impedance**  
 Conditions:  $V_{CE} = 20 \text{ V}$ ,  $I_E = 220 \text{ mA}$ ,  
 $T_{FLANGE} = 25^\circ\text{C}$

The graph shown below displays MTTF in hours  $\times$  ampere<sup>2</sup> emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  to the theoretical prediction for metal failure. Divide MTTF by  $I_C^2$  for MTTF in a particular application.



**Figure 7. MTTF Factor versus Junction Temperature**

## The RF Line

# Microwave Linear Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 2 GHz frequency range.

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  - Output Power — 3 Watts
  - Power Gain — 5 to 6 dB
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- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 24          | Vdc  |
| Collector-Base Voltage         | $V_{CES}$ | 50          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 8.5 | °C/W |

### ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                        |               |     |   |      |                  |
|------------------------------------------------------------------------|---------------|-----|---|------|------------------|
| Collector-Emitter Breakdown Voltage<br>( $I_C = 40$ mA, $I_B = 0$ )    | $V_{(BR)CEO}$ | 24  | — | —    | Vdc              |
| Collector-Emitter Breakdown Voltage<br>( $I_C = 40$ mA, $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 50  | — | —    | Vdc              |
| Collector-Base Breakdown Voltage<br>( $I_C = 2$ mA, $I_E = 0$ )        | $V_{(BR)CBO}$ | 45  | — | —    | Vdc              |
| Emitter-Base Breakdown Voltage<br>( $I_E = 0.5$ mA, $I_C = 0$ )        | $V_{(BR)EBO}$ | 3.5 | — | —    | Vdc              |
| Collector Cutoff Current ( $V_{CB} = 28$ V, $I_E = 0$ )                | $I_{CBO}$     | —   | — | 0.25 | mA <sub>dc</sub> |

### ON CHARACTERISTICS

|                                                   |          |    |   |     |   |
|---------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 200$ mA, $V_{CE} = 5$ V) | $h_{FE}$ | 20 | — | 120 | — |
|---------------------------------------------------|----------|----|---|-----|---|

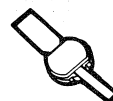
### DYNAMIC CHARACTERISTICS

|                                                                   |          |   |   |   |    |
|-------------------------------------------------------------------|----------|---|---|---|----|
| Output Capacitance<br>( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | — | 7 | pF |
|-------------------------------------------------------------------|----------|---|---|---|----|

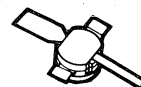
(continued)

## TRW52102 Series

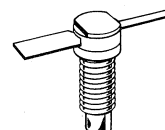
6 dB  
 1-2 GHz  
 3 WATTS  
 MICROWAVE  
 LINEAR POWER  
 TRANSISTORS



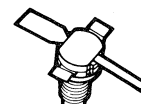
GP-13F  
 CASE 328E-01, STYLE 2  
 TRW52102



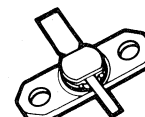
GP-14S  
 CASE 401A-01, STYLE 1  
 TRW52202



GP-13S  
 CASE 328G-01, STYLE 1  
 TRW52402



GP-14  
 CASE 401-01, STYLE 1  
 TRW52502



GP-13  
 CASE 328F-01, STYLE 1  
 TRW52602



ELECTRICAL CHARACTERISTICS — continued

| Characteristic                                                                                                                                                  | Symbol                                       | Min                            | Typ | Max        | Unit |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|--------------------------------|-----|------------|------|
| <b>FUNCTIONAL TESTS</b>                                                                                                                                         |                                              |                                |     |            |      |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 3\text{ W}$ , $f = 2\text{ GHz}$ , $I_E = 440\text{ mA}$ )                         | TRW52102<br>TRW52602<br>$G_{PE}$             | 6                              | —   | —          | dB   |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 3\text{ W}$ , $f = 2\text{ GHz}$ , $I_E = 440\text{ mA}$ )                         | TRW52202<br>TRW52402<br>TRW52502<br>$G_{PE}$ | 5                              | —   | —          | dB   |
| Load Mismatch<br>( $V_{CE} = 20\text{ V}$ , $I_E = 440\text{ mA}$ , $P_{out} = 3\text{ W}$ , $f = 2\text{ GHz}$ ,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$                                       | No Degradation in Output Power |     |            |      |
| Cutoff Frequency (Basic cell design)                                                                                                                            | $f_T$                                        | —                              | 2.7 | —          | GHz  |
| Gain Linearity<br>( $V_{CE} = 20\text{ V}$ , $I_E = 440\text{ mA}$ , $f = 2\text{ GHz}$ , $P_{O1} = 3\text{ W}$ , $P_{O2} = 3\text{ mW}$ )                      | $L_G$                                        | —                              | —   | -0.2<br>+1 | dB   |
| Intermodulation Distortion, 3rd Order<br>( $V_{CE} = 20\text{ V}$ , $I_E = 440\text{ mA}$ , $P_O$ (PEP) = 3 W,<br>Tones at 2 GHz and 2.005 GHz)                 | IMD                                          | —                              | -30 | —          | dB   |

TYPICAL CHARACTERISTICS

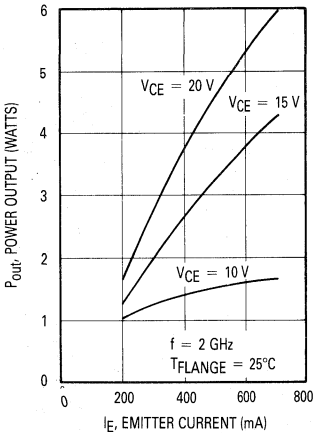


Figure 1. 1 dB Compression Point versus Emitter Current

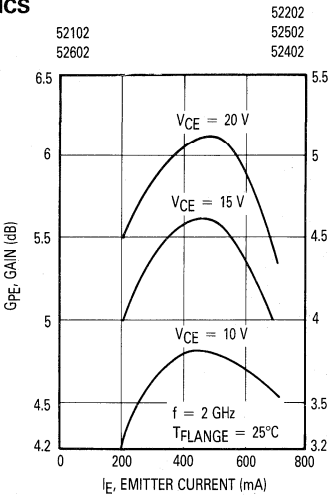


Figure 2. Gain versus Emitter Current

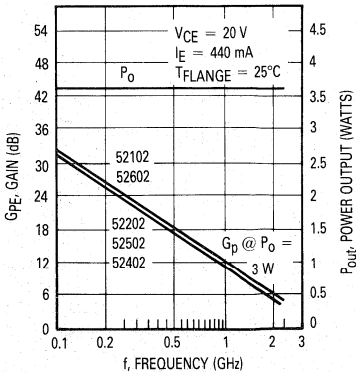


Figure 3. Gain and 1 dB Compressed Power versus Frequency

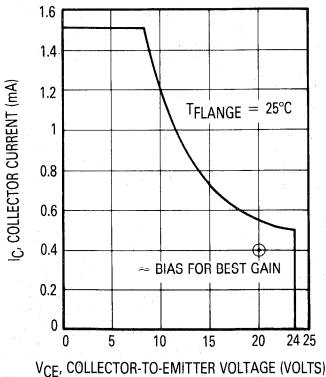


Figure 4. DC Safe Operating Area

$V_{CE} = 20V$   
 $I_E = 440mA$

| Frequency (GHz) | dB S11 | Ang   | dB S12 | Ang  | dB S21 | Ang   | dB S22 | Ang    |
|-----------------|--------|-------|--------|------|--------|-------|--------|--------|
| 400             | -0.62  | 173.4 | -31.57 | 22.2 | 9.92   | 70.3  | -6.21  | -171.3 |
| 500             | -0.57  | 169.7 | -31.21 | 23.8 | 8.19   | 64.3  | -6.15  | -173.0 |
| 600             | -0.52  | 167.9 | -30.53 | 26.5 | 6.40   | 59.1  | -5.91  | -174.1 |
| 700             | -0.91  | 166.2 | -29.91 | 28.2 | 4.73   | 51.8  | -5.77  | -175.9 |
| 800             | -1.17  | 160.9 | -29.40 | 29.8 | 3.63   | 44.0  | -5.55  | -176.0 |
| 900             | -0.70  | 158.6 | -28.62 | 30.8 | 2.69   | 39.1  | -5.40  | -177.7 |
| 1000            | -0.75  | 155.9 | -28.04 | 30.0 | 1.81   | 34.5  | -5.22  | -179.0 |
| 1100            | -0.74  | 153.1 | -27.44 | 31.0 | 0.81   | 28.7  | -4.84  | 179.9  |
| 1200            | -0.72  | 150.5 | -26.90 | 30.3 | 0.07   | 23.2  | -4.72  | 177.7  |
| 1300            | -0.72  | 148.0 | -26.34 | 30.2 | -0.61  | 18.0  | -4.48  | 177.0  |
| 1400            | -0.72  | 145.5 | -25.93 | 29.5 | -1.48  | 13.4  | -4.27  | 173.6  |
| 1500            | -0.83  | 143.9 | -25.55 | 27.8 | -2.15  | 8.2   | -4.11  | 172.2  |
| 1600            | -0.73  | 140.9 | -25.06 | 26.6 | -2.71  | 2.8   | -3.74  | 169.5  |
| 1700            | -0.73  | 138.6 | -24.77 | 27.0 | -3.35  | -0.4  | -3.66  | 167.8  |
| 1800            | -0.75  | 136.3 | -24.26 | 24.4 | -3.93  | -6.5  | -3.40  | 166.2  |
| 1900            | -0.72  | 133.8 | -24.10 | 23.2 | -4.34  | -11.0 | -3.56  | 162.5  |
| 2000            | -0.69  | 131.3 | -23.35 | 24.4 | -4.89  | -12.0 | -3.33  | 162.5  |
| 2100            | -0.77  | 128.8 | -23.61 | 20.3 | -5.51  | -19.5 | -2.94  | 157.4  |
| 2200            | -0.77  | 126.6 | -23.17 | 19.1 | -5.91  | -23.4 | -2.88  | 155.4  |
| 2300            | -0.78  | 124.3 | -22.86 | 17.5 | -6.30  | -26.2 | -2.70  | 153.5  |
| 2400            | -0.78  | 121.9 | -22.59 | 17.5 | -6.97  | -29.7 | -2.70  | 151.2  |
| 2500            | -0.78  | 119.7 | -22.11 | 14.2 | -7.25  | -34.6 | -2.53  | 149.5  |
| 2600            | -0.80  | 117.2 | -21.73 | 13.0 | -7.56  | -37.2 | -2.41  | 146.5  |
| 2700            | -0.81  | 114.7 | -21.33 | 13.0 | -8.03  | -39.9 | -2.35  | 144.6  |
| 2800            | -0.82  | 112.5 | -21.06 | 10.0 | -8.37  | -44.5 | -2.23  | 142.7  |
| 2900            | -0.84  | 109.3 | -20.58 | 7.3  | -8.60  | -48.2 | -2.15  | 140.2  |
| 3000            | -0.62  | 108.0 | -20.25 | 6.7  | -8.78  | -49.3 | -2.05  | 138.1  |

Figure 5. Common Emitter S-Parameters

The graph shown below displays MTTF in hours x ampere<sup>2</sup> emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  to the theoretical prediction for metal failure. Divide MTTF by  $I_C^2$  for MTTF in a particular application.

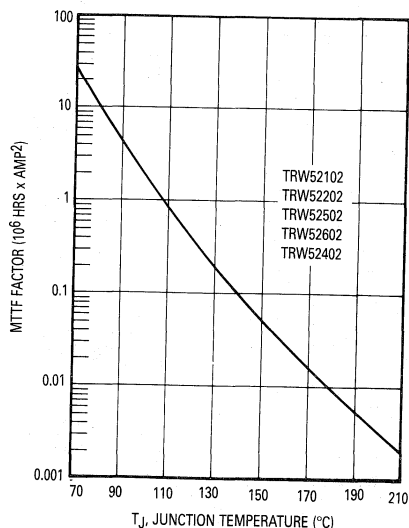


Figure 6. MTTF Factor versus Junction Temperature

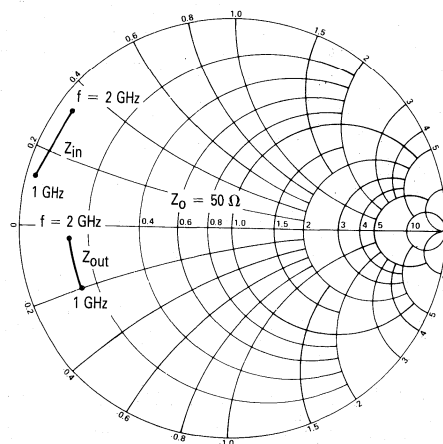


Figure 7. Series Equivalent Input/Output Impedance

**The RF Line**

**Microwave Linear  
Power Transistors**

2

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 2 GHz frequency range.

- Designed for Class A, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  - Output Power — 6 Watts
  - Power Gain — 4.8 dB, Min
- Variety of Package Options, Including Hermetic
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 24          | Vdc  |
| Collector-Base Voltage         | $V_{CES}$ | 50          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 6   | °C/W |

**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                                |               |     |   |     |      |
|--------------------------------------------------------------------------------|---------------|-----|---|-----|------|
| Collector-Emitter Breakdown Voltage<br>( $I_C = 80\text{ mA}$ , $I_E = 0$ )    | $V_{(BR)CEO}$ | 24  | — | —   | Vdc  |
| Collector-Emitter Breakdown Voltage<br>( $I_C = 80\text{ mA}$ , $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 50  | — | —   | Vdc  |
| Collector-Base Breakdown Voltage<br>( $I_C = 4\text{ mA}$ , $I_E = 0$ )        | $V_{(BR)CBO}$ | 45  | — | —   | Vdc  |
| Emitter-Base Breakdown Voltage<br>( $I_E = 1\text{ mA}$ , $I_C = 0$ )          | $V_{(BR)EBO}$ | 3.5 | — | —   | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 28\text{ V}$ , $I_E = 0$ )                | $I_{CBO}$     | —   | — | 0.5 | mAdc |

**ON CHARACTERISTICS**

|                                                                   |          |    |   |     |   |
|-------------------------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 400\text{ mA}$ , $V_{CE} = 5\text{ V}$ ) | $h_{FE}$ | 20 | — | 120 | — |
|-------------------------------------------------------------------|----------|----|---|-----|---|

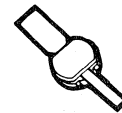
**DYNAMIC CHARACTERISTICS**

|                                                                                   |          |   |   |    |    |
|-----------------------------------------------------------------------------------|----------|---|---|----|----|
| Output Capacitance<br>( $V_{CB} = 28\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ ) | $C_{ob}$ | — | — | 12 | pF |
|-----------------------------------------------------------------------------------|----------|---|---|----|----|

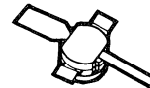
(continued)

**TRW52104  
Series**

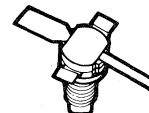
4.8 dB  
1 TO 2 GHz  
6 WATTS  
MICROWAVE  
LINEAR POWER  
TRANSISTORS



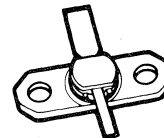
GP-13F  
CASE 328E-01, STYLE 2  
TRW52104



GP-14S  
CASE 401A-01, STYLE 1  
TRW52204



GP-14  
CASE 401-01, STYLE 1  
TRW52504



GP-13  
CASE 328F-01, STYLE 1  
TRW52604

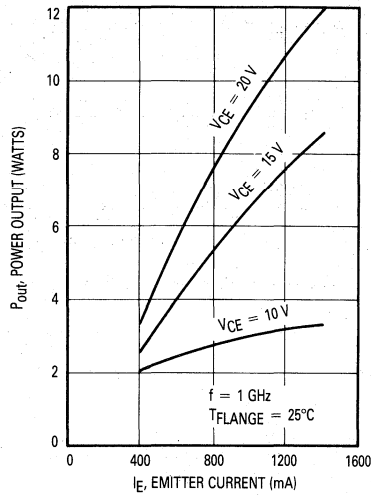
# TRW52104 Series

**ELECTRICAL CHARACTERISTICS — continued** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

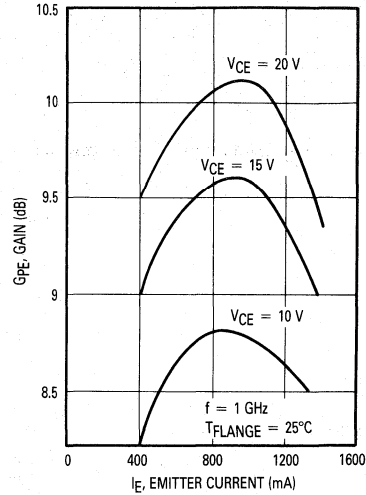
| Characteristic                                                                                                                                          | Symbol   | Min                            | Typ | Max        | Unit |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------|-----|------------|------|
| <b>FUNCTIONAL TESTS</b>                                                                                                                                 |          |                                |     |            |      |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 6\text{ W}$ , $f = 2\text{ GHz}$ , $I_E = 880\text{ mA}$ )                 | $G_{PE}$ | 4.8                            | —   | —          | dB   |
| Load Mismatch<br>( $V_{CE} = 20\text{ V}$ , $I_E = 880\text{ mA}$ , $P_{out} = 6\text{ W}$ , $f = 2\text{ GHz}$ ,<br>Load VSWR = 3:1, All Phase Angles) | $\psi$   | No Degradation in Output Power |     |            |      |
| Cutoff Frequency (Basic cell design)                                                                                                                    | $f_r$    | —                              | 2.7 | —          | GHz  |
| Gain Linearity<br>( $V_{CE} = 20\text{ V}$ , $I_E = 880\text{ mA}$ , $f = 2\text{ GHz}$ , $P_{O1} = 6\text{ W}$ , $P_{O2} = 6\text{ mW}$ )              | $L_G$    | —                              | —   | -0.2<br>+1 | dB   |
| Intermodulation Distortion, 3rd Order<br>( $V_{CE} = 20\text{ V}$ , $I_E = 880\text{ mA}$ , $P_O$ (PEP) = 6 W,<br>Tones at 1 GHz and 1.005 GHz)         | IMD      | —                              | -30 | —          | dB   |

2

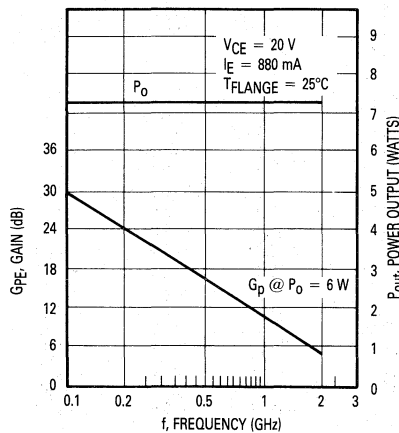
## TYPICAL CHARACTERISTICS



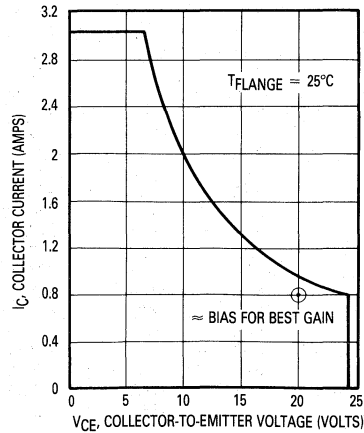
**Figure 1. 1 dB Compression Point versus Emitter Current**



**Figure 2. Gain versus Emitter Current**



**Figure 3. Gain and 1 dB Compressed Power versus Frequency**



**Figure 4. DC Safe Operating Area**

TRW52604, 104 S-PARAMETERS

Large Signal  
Impedance Data  
(5Ω Center)

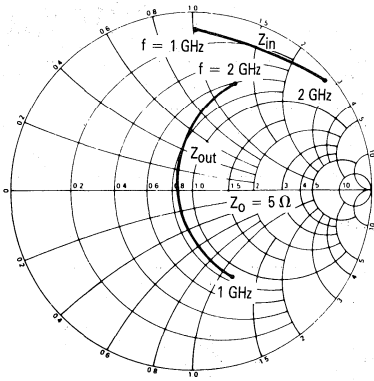


Figure 5. Series Equivalent Input/Output Impedance

The graph shown below displays MTTF in hours x ampere<sup>2</sup> emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  to the theoretical prediction for metal failure. Divide MTTF by  $I_C^2$  for MTTF in a particular application.

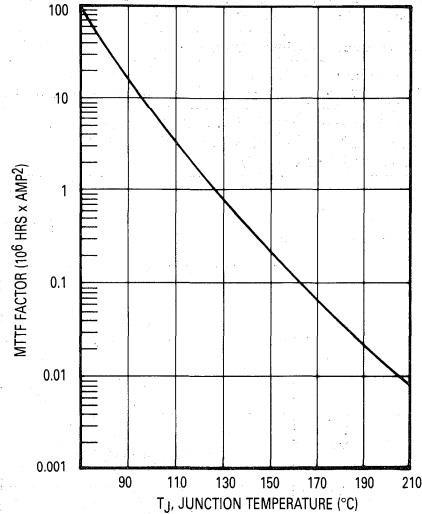


Figure 6. MTTF Factor versus Junction Temperature

| Vce = 20V       |       |       |        |      |        |       |       |       |
|-----------------|-------|-------|--------|------|--------|-------|-------|-------|
| Ic = 600mA      |       |       |        |      |        |       |       |       |
| Frequency (MHz) | S11   |       | S12    |      | S21    |       | S22   |       |
|                 | dB    | Ang   | dB     | Ang  | dB     | Ang   | dB    | Ang   |
| 400             | -0.37 | 172.0 | -33.82 | 29.7 | 5.11   | 70.5  | -2.66 | 177.1 |
| 500             | -0.36 | 169.6 | -33.06 | 32.8 | 3.22   | 65.7  | -2.75 | 175.3 |
| 600             | -0.39 | 167.1 | -32.21 | 36.3 | 1.52   | 60.2  | -2.61 | 174.2 |
| 700             | -0.40 | 164.8 | -31.44 | 37.7 | 0.18   | 54.7  | -2.59 | 171.9 |
| 800             | -0.43 | 162.7 | -30.66 | 39.2 | -0.97  | 50.2  | -2.55 | 171.2 |
| 900             | -0.40 | 160.0 | -29.61 | 40.9 | -2.09  | 44.7  | -2.50 | 168.6 |
| 1000            | -0.45 | 157.6 | -28.99 | 40.7 | -2.93  | 40.3  | -2.53 | 167.1 |
| 1100            | -0.43 | 155.2 | -28.28 | 40.7 | -3.77  | 35.3  | -2.31 | 166.0 |
| 1200            | -0.42 | 152.9 | -27.72 | 39.4 | -4.49  | 30.8  | -2.39 | 163.5 |
| 1300            | -0.41 | 150.7 | -27.08 | 39.2 | -5.10  | 26.2  | -2.30 | 162.8 |
| 1400            | -0.41 | 148.6 | -26.58 | 38.8 | -5.90  | 22.3  | -2.22 | 159.4 |
| 1500            | -0.52 | 147.1 | -26.20 | 37.2 | -6.54  | 17.9  | -2.24 | 158.3 |
| 1600            | -0.41 | 144.5 | -25.65 | 36.4 | -7.05  | 13.2  | -2.02 | 155.8 |
| 1700            | -0.42 | 142.6 | -25.30 | 36.8 | -7.60  | 10.5  | -2.08 | 154.6 |
| 1800            | -0.42 | 140.6 | -24.77 | 34.2 | -8.23  | 5.3   | -1.92 | 153.2 |
| 1900            | -0.39 | 138.4 | -24.64 | 33.5 | -8.64  | 1.5   | -2.22 | 150.1 |
| 2000            | -0.34 | 136.4 | -23.80 | 34.1 | -9.08  | 0.4   | -2.05 | 150.0 |
| 2100            | -0.42 | 134.4 | -23.72 | 30.4 | -9.66  | -5.0  | -1.81 | 146.1 |
| 2200            | -0.42 | 132.6 | -23.27 | 29.0 | -10.03 | -8.4  | -1.80 | 144.6 |
| 2300            | -0.41 | 130.8 | -22.95 | 27.4 | -10.36 | -10.6 | -1.71 | 143.1 |
| 2400            | -0.42 | 128.9 | -22.69 | 27.8 | -10.87 | -13.1 | -1.75 | 141.1 |
| 2500            | -0.41 | 127.1 | -22.27 | 24.6 | -11.11 | -17.1 | -1.66 | 139.8 |
| 2600            | -0.42 | 125.0 | -21.95 | 23.5 | -11.41 | -19.1 | -1.59 | 137.5 |
| 2700            | -0.42 | 123.0 | -21.51 | 24.0 | -11.81 | -20.6 | -1.55 | 136.0 |
| 2800            | -0.41 | 121.3 | -21.30 | 21.3 | -12.14 | -24.3 | -1.50 | 134.5 |
| 2900            | -0.41 | 119.0 | -20.84 | 19.5 | -12.35 | -27.2 | -1.43 | 132.3 |
| 3000            | 10.18 | 118.2 | -20.52 | 18.5 | -12.46 | -26.9 | -1.39 | 130.6 |

Figure 7. Common Emitter S-Parameters

## The RF Line

# Microwave Linear Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 3 GHz frequency range.

- Designed for Class A, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 3 GHz Characteristics:  
 Output Power — 0.8 Watts  
 Power Gain — 7.5 to 8.5 dB, Min
- Variety of Package Options, Including Hermetic
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 22          | Vdc  |
| Collector-Base Voltage         | $V_{CES}$ | 50          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 31  | °C/W |

### ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                                 |               |     |   |      |                  |
|---------------------------------------------------------------------------------|---------------|-----|---|------|------------------|
| Collector-Emitter Breakdown Voltage<br>( $I_C = 10 \text{ mA}$ , $I_B = 0$ )    | $V_{(BR)CEO}$ | 22  | — | —    | Vdc              |
| Collector-Emitter Breakdown Voltage<br>( $I_C = 10 \text{ mA}$ , $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 50  | — | —    | Vdc              |
| Collector-Base Breakdown Voltage<br>( $I_C = 1 \text{ mA}$ , $I_E = 0$ )        | $V_{(BR)CBO}$ | 45  | — | —    | Vdc              |
| Emitter-Base Breakdown Voltage<br>( $I_E = 0.25 \text{ mA}$ , $I_C = 0$ )       | $V_{(BR)EBO}$ | 3.5 | — | —    | Vdc              |
| Collector Cutoff Current ( $V_{CB} = 28 \text{ V}$ , $I_E = 0$ )                | $I_{CBO}$     | —   | — | 0.25 | mA <sub>dc</sub> |

### ON CHARACTERISTICS

|                                                                     |          |    |   |     |   |
|---------------------------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 100 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ ) | $h_{FE}$ | 20 | — | 120 | — |
|---------------------------------------------------------------------|----------|----|---|-----|---|

### DYNAMIC CHARACTERISTICS

|                                                                                     |          |   |   |     |    |
|-------------------------------------------------------------------------------------|----------|---|---|-----|----|
| Output Capacitance<br>( $V_{CB} = 28 \text{ V}$ , $I_E = 0$ , $f = 1 \text{ MHz}$ ) | $C_{ob}$ | — | — | 3.5 | pF |
|-------------------------------------------------------------------------------------|----------|---|---|-----|----|

(continued)

## TRW53001 Series

7.5 TO 8.5 dB  
 1 TO 3 GHz  
 0.8 WATT  
 MICROWAVE  
 LINEAR POWER  
 TRANSISTORS



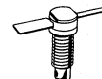
TW-200  
 CASE 400-01, STYLE 1  
 TRW53001



GP-13F  
 CASE 328E-01, STYLE 2  
 TRW53101



GP-14S  
 CASE 401A-01, STYLE 1  
 TRW53201



GP-13S  
 CASE 328G-01, STYLE 1  
 TRW53401



GP-14  
 CASE 401-01, STYLE 1  
 TRW53501



GP-13  
 CASE 328F-01, STYLE 1  
 TRW53601

## ELECTRICAL CHARACTERISTICS — continued

| Characteristic                                                                                                                                            | Symbol                           | Min                               | Typ    | Max        | Unit |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------|--------|------------|------|-----|
| FUNCTIONAL TESTS                                                                                                                                          |                                  |                                   |        |            |      |     |
| Common-Emitter Amplifier Power Gain<br>(V <sub>CE</sub> = 20 V, P <sub>out</sub> = 0.8 W, f = 3 GHz)                                                      | TRW53001<br>TRW53101<br>TRW53601 | G <sub>PE</sub>                   | 8.5    | —          | —    | dB  |
| Common-Emitter Amplifier Power Gain<br>(V <sub>CE</sub> = 20 V, P <sub>out</sub> = 0.8 W, f = 3 GHz)                                                      | TRW53201<br>TRW53401<br>TRW53501 | G <sub>PE</sub>                   | 7.5    | —          | —    | dB  |
| Load Mismatch<br>(V <sub>CE</sub> = 20 V, I <sub>E</sub> = 120 mA, P <sub>out</sub> = 0.8 W, f = 3 GHz,<br>Load VSWR = ∞:1, All Phase Angles)             | ψ                                | No Degradation in<br>Output Power |        |            |      |     |
| Cutoff Frequency (V <sub>CE</sub> = 20 V, I <sub>E</sub> = 120 mA)                                                                                        | f <sub>T</sub>                   | —                                 | 3      | —          | —    | GHz |
| Gain Linearity<br>(V <sub>CE</sub> = 20 V, I <sub>E</sub> = 120 mA, f = 3 GHz,<br>P <sub>O1</sub> = 0.8 W, P <sub>O2</sub> = 0.8 mW)                      | L <sub>G</sub>                   | —<br>—                            | —<br>— | —0.2<br>+1 | —    | dB  |
| Intermodulation Distortion, 3rd Order<br>(V <sub>CE</sub> = 20 V, I <sub>E</sub> = 120 mA, P <sub>O</sub> (PEP) = 0.8 W,<br>Tones at 3 GHz and 3.005 GHz) | IMD                              | —                                 | —30    | —          | —    | dB  |

## TYPICAL CHARACTERISTICS

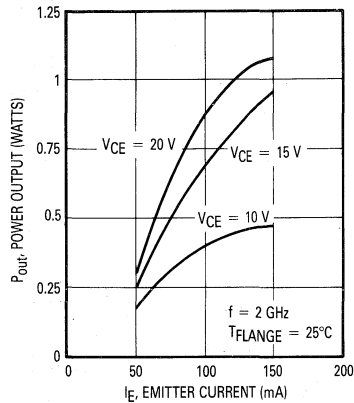


Figure 1. 1 dB Compression Point versus Emitter Current

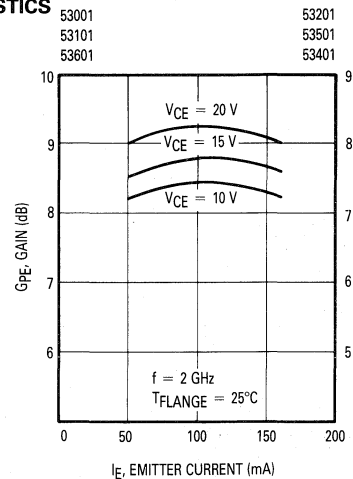


Figure 2. Gain versus Emitter Current

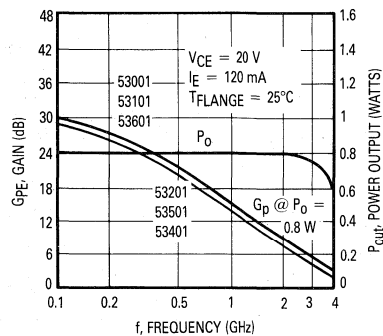


Figure 3. Gain and 1 dB Compressed Power versus Frequency

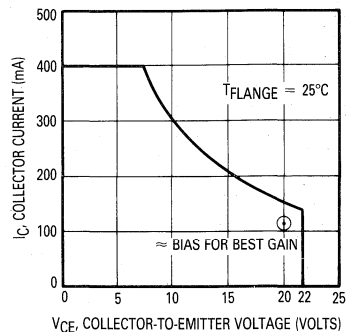


Figure 4. DC Safe Operating Area

# TRW53001 Series

VCE = 20V  
IE = 120mA

## TRW53601/101

| Frequency (MHz) | S11   |         | S12   |       | S21     |        | S22   |         |
|-----------------|-------|---------|-------|-------|---------|--------|-------|---------|
|                 | Mag   | Angle   | Mag   | Angle | Mag     | Angle  | Mag   | Angle   |
| 100             | .6974 | -144.70 | .0212 | 30.40 | 20.0678 | 113.30 | .4759 | -57.30  |
| 200             | .7730 | -159.30 | .0251 | 25.90 | 11.2073 | 99.20  | .3931 | -63.50  |
| 300             | .8175 | -167.80 | .0265 | 21.10 | 8.0353  | 86.50  | .3540 | -69.50  |
| 400             | .8341 | -173.70 | .0273 | 21.30 | 6.0464  | 79.40  | .3447 | -76.00  |
| 500             | .8279 | -177.40 | .0287 | 21.70 | 4.9091  | 71.10  | .3585 | -81.60  |
| 600             | .8308 | -179.60 | .0296 | 22.10 | 4.0785  | 64.40  | .3728 | -87.20  |
| 700             | .8270 | -176.90 | .0308 | 23.60 | 3.4714  | 59.30  | .3913 | -92.30  |
| 800             | .8279 | -175.00 | .0338 | 23.20 | 3.2026  | 52.80  | .4222 | -96.40  |
| 900             | .8194 | -171.60 | .0330 | 25.00 | 2.6669  | 48.60  | .4305 | -103.20 |
| 1000            | .8185 | -169.50 | .0356 | 24.90 | 2.4803  | 42.30  | .4597 | -107.60 |
| 1100            | .8270 | -167.40 | .0378 | 25.20 | 2.2646  | 37.00  | .4831 | -112.50 |
| 1200            | .8026 | -164.30 | .0385 | 22.10 | 2.0773  | 29.40  | .5140 | -117.70 |
| 1300            | .8119 | -162.20 | .0407 | 25.90 | 1.8664  | 27.90  | .5426 | -121.60 |
| 1400            | .8082 | -160.10 | .0436 | 24.40 | 1.7721  | 21.70  | .5702 | -125.30 |
| 1500            | .9026 | -157.80 | .0453 | 22.40 | 1.6274  | 15.20  | .5841 | -129.30 |
| 1600            | .7962 | -155.20 | .0458 | 22.60 | 1.4504  | 11.10  | .6173 | -131.70 |
| 1700            | .8035 | -152.30 | .0497 | 23.90 | 1.4158  | 9.60   | .6561 | -133.90 |
| 1800            | .7780 | -148.50 | .0533 | 21.60 | 1.3552  | 2.50   | .6561 | -136.60 |
| 1900            | .7709 | -144.50 | .0548 | 19.70 | 1.2503  | -3.10  | .6622 | -139.30 |
| 2000            | .7834 | -141.00 | .0573 | 20.30 | 1.1708  | -5.60  | .6668 | -141.90 |
| 2100            | .7980 | -137.50 | .0616 | 18.30 | 1.1468  | -10.70 | .6738 | -144.70 |
| 2200            | .8185 | -134.50 | .0640 | 16.00 | 1.0777  | -15.70 | .6784 | -148.10 |
| 2300            | .8308 | -132.20 | .0668 | 15.20 | 1.0221  | -19.70 | .6879 | -151.30 |
| 2400            | .8453 | -130.30 | .0698 | 12.90 | .9795   | -24.70 | .6974 | -154.90 |
| 2500            | .9414 | -129.80 | .0716 | 11.20 | .9078   | -28.60 | .7194 | -158.20 |
| 2600            | .9194 | -127.40 | .0747 | 11.50 | .8670   | -31.10 | .7371 | -160.80 |
| 2700            | .7852 | -125.10 | .0799 | 9.80  | .8472   | -34.70 | .7560 | -160.00 |
| 2800            | .7388 | -121.70 | .0837 | 8.40  | .8091   | -38.50 | .7736 | -164.90 |
| 2900            | .6816 | -117.10 | .0877 | 7.80  | .7789   | -40.50 | .7907 | -166.50 |
| 3000            | .6419 | -109.50 | .0969 | 6.20  | .7934   | -43.40 | .7980 | -168.00 |
| 3100            | .6081 | -100.70 | .1030 | 3.00  | .7798   | -48.90 | .8110 | -169.60 |
| 3200            | .5895 | -91.60  | .1076 | .40   | .7630   | -52.80 | .8026 | -171.60 |
| 3300            | .6145 | -82.20  | .1193 | -1.80 | .7674   | -56.90 | .7934 | -174.00 |

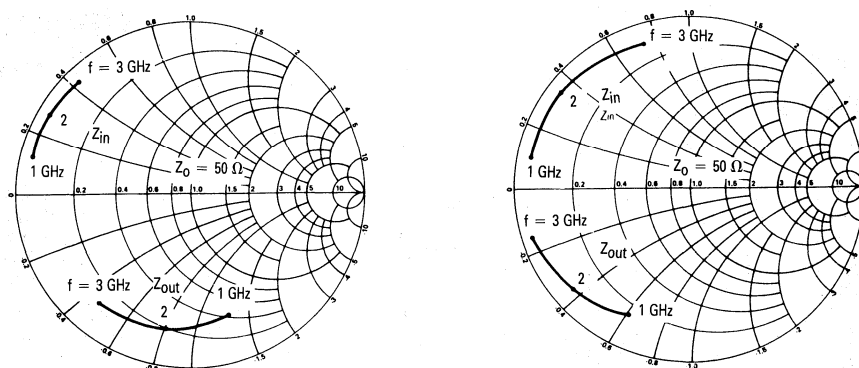
VCE = 20V  
IE = 120mA

## TRW53001

| Frequency (MHz) | S11   |         | S12   |       | S21     |        | S22   |         |
|-----------------|-------|---------|-------|-------|---------|--------|-------|---------|
|                 | Mag   | Angle   | Mag   | Angle | Mag     | Angle  | Mag   | Angle   |
| 100             | .7055 | -148.60 | .0199 | 34.70 | 18.6638 | 111.10 | .4534 | -46.90  |
| 200             | .7551 | -163.60 | .0240 | 34.30 | 10.1742 | 98.40  | .3631 | -47.30  |
| 300             | .7852 | -171.40 | .0269 | 35.50 | 7.2946  | 87.50  | .3214 | -51.70  |
| 400             | .7962 | -176.90 | .0288 | 39.60 | 5.5335  | 80.30  | .3055 | -55.30  |
| 500             | .8008 | -179.30 | .0317 | 43.10 | 4.4875  | 74.20  | .3087 | -59.30  |
| 600             | .8072 | -176.10 | .0348 | 45.80 | 3.7540  | 68.40  | .3130 | -64.00  |
| 700             | .8091 | -173.40 | .0374 | 48.40 | 3.1879  | 63.60  | .3181 | -68.20  |
| 800             | .8072 | -171.10 | .0427 | 51.80 | 2.9074  | 59.90  | .3308 | -72.60  |
| 900             | .8147 | -167.90 | .0437 | 52.00 | 2.4547  | 53.60  | .3281 | -78.10  |
| 1000            | .8166 | -165.60 | .0489 | 53.80 | 2.2673  | 49.60  | .3440 | -93.20  |
| 1100            | .8308 | -163.60 | .0530 | 55.20 | 2.0300  | 44.70  | .3471 | -99.60  |
| 1200            | .8299 | -160.60 | .0591 | 54.20 | 1.9077  | 38.70  | .3602 | -9.680  |
| 1300            | .8443 | -158.60 | .0598 | 55.90 | 1.6924  | 36.30  | .3798 | -102.30 |
| 1400            | .8375 | -156.50 | .0646 | 56.80 | 1.5668  | 32.90  | .4055 | -107.30 |
| 1500            | .8404 | -154.80 | .0721 | 59.40 | 1.4859  | 28.90  | .4350 | -110.90 |
| 1600            | .8443 | -152.80 | .0769 | 56.70 | 1.3693  | 23.20  | .4576 | -115.10 |
| 1700            | .8770 | -151.10 | .0802 | 58.50 | 1.2445  | 21.60  | .4786 | -117.30 |
| 1800            | .8395 | -184.90 | .0884 | 58.80 | 1.2036  | 18.70  | .5018 | -118.90 |
| 1900            | .8414 | -146.40 | .0965 | 57.00 | 1.1548  | 14.00  | .5146 | -121.30 |
| 2000            | .8404 | -144.00 | .0994 | 55.30 | 1.0544  | 9.60   | .5206 | -124.30 |
| 2100            | .8424 | -141.60 | .1058 | 56.00 | 1.0035  | 8.00   | .5254 | -127.10 |
| 2200            | .9472 | -139.20 | .1131 | 54.50 | .9572   | 4.30   | .5352 | -101.00 |
| 2300            | .8502 | -136.80 | .1176 | 52.90 | .8964   | .90    | .5483 | -135.40 |
| 2400            | .8541 | -134.90 | .1259 | 53.10 | .8502   | -.80   | .5643 | -139.50 |
| 2500            | .8590 | -133.90 | .1346 | 51.40 | .8204   | -3.90  | .5888 | -142.80 |
| 2600            | .8561 | -130.50 | .1403 | 49.50 | .7709   | -6.80  | .6730 | -148.00 |
| 2700            | .8492 | -128.40 | .1466 | 49.40 | .7311   | -8.30  | .6353 | -147.50 |
| 2800            | .8443 | -126.30 | .1565 | 48.60 | .7153   | -10.00 | .6509 | -149.20 |
| 2900            | .8424 | -123.80 | .1669 | 45.80 | .6918   | -13.60 | .6653 | -150.80 |
| 3000            | .8308 | -121.20 | .1706 | 44.50 | .6464   | -15.70 | .6761 | -151.70 |
| 3100            | .8270 | -118.30 | .1824 | 43.90 | .6339   | -16.50 | .6753 | -153.30 |
| 3200            | .8308 | -115.00 | .1950 | 41.30 | .6216   | -19.60 | .6761 | -155.40 |
| 3300            | .8453 | -112.50 | .1966 | 38.10 | .5848   | -22.60 | .6847 | -158.10 |

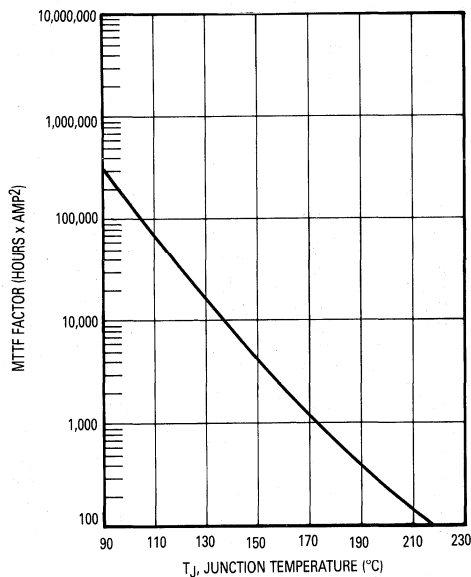
Figure 5. Common Emitter S-Parameters





**Figure 6. Series Equivalent Input/Output Impedance**  
**Conditions:  $V_{CE} = 20$  V,  $I_E = 120$  mA,**  
 **$T_{FLANGE} = 25^\circ\text{C}$**

The graph shown below displays MTTF in hours  $\times$  ampere<sup>2</sup> emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  to the theoretical prediction for metal failure. Divide MTTF by  $I_C^2$  for MTTF in a particular application.



**Figure 7. MTTF Factor versus Junction Temperature**

**The RF Line**

**Microwave Linear Power Transistors**

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 3 GHz frequency range.

- Designed for Class A, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:  
 Output Power — 1.6 Watts  
 Power Gain — 7 to 8 dB
- Variety of Package Options, Including Hermetic
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 22          | Vdc  |
| Collector-Base Voltage         | $V_{CES}$ | 50          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 17  | °C/W |

**ELECTRICAL CHARACTERISTICS**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                                 |               |     |   |     |      |
|---------------------------------------------------------------------------------|---------------|-----|---|-----|------|
| Collector-Emitter Breakdown Voltage<br>( $I_C = 20 \text{ mA}$ , $I_B = 0$ )    | $V_{(BR)CEO}$ | 22  | — | —   | Vdc  |
| Collector-Emitter Breakdown Voltage<br>( $I_C = 20 \text{ mA}$ , $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 50  | — | —   | Vdc  |
| Collector-Base Breakdown Voltage<br>( $I_C = 2 \text{ mA}$ , $I_E = 0$ )        | $V_{(BR)CBO}$ | 45  | — | —   | Vdc  |
| Emitter-Base Breakdown Voltage<br>( $I_E = 0.5 \text{ mA}$ , $I_C = 0$ )        | $V_{(BR)EBO}$ | 3.5 | — | —   | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 28 \text{ V}$ , $I_E = 0$ )                | $I_{CBO}$     | —   | — | 0.5 | mAdc |

**ON CHARACTERISTICS**

|                                                                     |          |    |   |     |   |
|---------------------------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 200 \text{ mA}$ , $V_{CE} = 5 \text{ V}$ ) | $h_{FE}$ | 20 | — | 120 | — |
|---------------------------------------------------------------------|----------|----|---|-----|---|

**DYNAMIC CHARACTERISTICS**

|                                                                                     |          |   |   |     |    |
|-------------------------------------------------------------------------------------|----------|---|---|-----|----|
| Output Capacitance<br>( $V_{CB} = 28 \text{ V}$ , $I_E = 0$ , $f = 1 \text{ MHz}$ ) | $C_{ob}$ | — | — | 5.5 | pF |
|-------------------------------------------------------------------------------------|----------|---|---|-----|----|

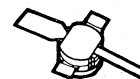
(continued)

**TRW53102 Series**

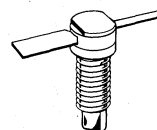
7 TO 8 dB  
 1-3 GHz  
 1.6 WATTS  
 MICROWAVE  
 LINEAR POWER  
 TRANSISTORS



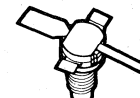
GP-13F  
 CASE 328E-01, STYLE 2  
 TRW53102



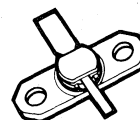
GP-14S  
 CASE 401A-01, STYLE 1  
 TRW53202



GP-13S  
 CASE 328G-01, STYLE 1  
 TRW53402



GP-14  
 CASE 401-01, STYLE 1  
 TRW53502



GP-13  
 CASE 328F-01, STYLE 1  
 TRW53602

ELECTRICAL CHARACTERISTICS — continued

| Characteristic                                                                                                                                    | Symbol                           | Min                               | Typ | Max        | Unit |
|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------|-----|------------|------|
| <b>FUNCTIONAL TESTS</b>                                                                                                                           |                                  |                                   |     |            |      |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 1.6\text{ W}$ , $f = 2\text{ GHz}$ , $I_E = 230\text{ mA}$ )         | TRW53102<br>TRW53602             | GPE                               | 8   | —          | dB   |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 1.6\text{ W}$ , $f = 2\text{ GHz}$ , $I_E = 230\text{ mA}$ )         | TRW53202<br>TRW53402<br>TRW53502 | GPE                               | 7   | —          | dB   |
| Load Mismatch<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 1.6\text{ W}$ , $f = 2\text{ GHz}$ ,<br>Load VSWR = $\infty:1$ , All Phase Angles)         | $\psi$                           | No Degradation in<br>Output Power |     |            |      |
| Cutoff Frequency (Basic cell design)                                                                                                              | $f_T$                            | —                                 | 3   | —          | GHz  |
| Gain Linearity<br>( $V_{CE} = 20\text{ V}$ , $I_E = 230\text{ mA}$ , $f = 2\text{ GHz}$ ,<br>$P_{O1} = 1.6\text{ W}$ , $P_{O2} = 1.6\text{ mW}$ ) | L <sub>G</sub>                   | —                                 | —   | -0.2<br>+1 | dB   |
| Intermodulation Distortion, 3rd Order<br>( $V_{CE} = 20\text{ V}$ , $I_E = 230\text{ mA}$ , $P_O$ (PEP) = 1.6 W,<br>Tones at 2 GHz and 2.005 GHz) | IMD                              | —                                 | -30 | —          | dB   |

TYPICAL CHARACTERISTICS

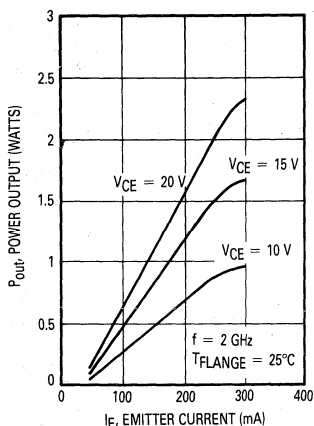


Figure 1. 1 dB Compression Point versus Emitter Current

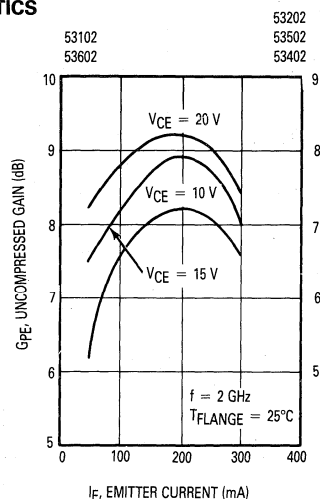


Figure 2. Gain versus Emitter Current

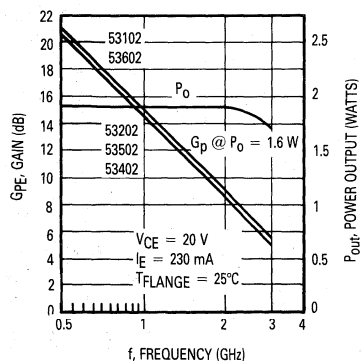


Figure 3. Gain and 1 dB Compressed Power versus Frequency

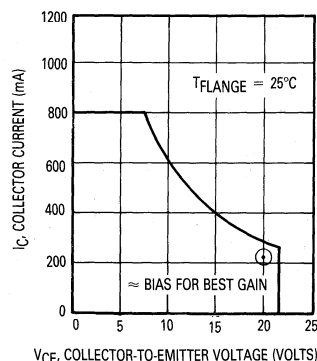


Figure 4. DC Safe Operating Area

VCE = 20V  
IE = 230mA

| Frequency (MHz) | S11   |       | S12    |      | S21   |       | S22   |        |
|-----------------|-------|-------|--------|------|-------|-------|-------|--------|
|                 | dB    | Ang   | dB     | Ang  | dB    | Ang   | dB    | Ang    |
| 400             | -1.22 | 178.6 | -30.27 | 16.8 | 13.25 | 71.9  | -9.89 | -129.1 |
| 500             | -1.17 | 174.6 | -30.07 | 17.2 | 11.24 | 65.2  | -9.38 | -133.0 |
| 600             | -1.16 | 171.1 | -29.84 | 18.9 | 9.56  | 57.8  | -8.84 | -137.4 |
| 700             | -1.16 | 167.9 | -29.56 | 20.5 | 8.15  | 50.9  | -8.24 | -140.0 |
| 800             | -1.16 | 165.2 | -29.24 | 21.9 | 6.90  | 44.9  | -7.61 | -143.0 |
| 900             | -1.11 | 161.8 | -28.90 | 23.6 | 5.68  | 37.8  | -6.96 | -145.8 |
| 1000            | -1.16 | 158.9 | -28.46 | 24.7 | 4.72  | 32.7  | -6.46 | -149.2 |
| 1100            | -1.13 | 156.0 | -28.08 | 25.8 | 3.75  | 26.3  | -5.86 | -152.4 |
| 1200            | -1.11 | 153.2 | -27.56 | 25.7 | 2.88  | 20.5  | -5.50 | -156.2 |
| 1300            | -1.09 | 150.6 | -27.08 | 26.5 | 2.15  | 15.2  | -5.06 | -158.6 |
| 1400            | -1.08 | 147.9 | -26.69 | 27.2 | 1.20  | 10.3  | -4.71 | -162.9 |
| 1500            | -1.19 | 146.2 | -26.28 | 26.6 | 0.47  | 4.8   | -4.39 | -166.1 |
| 1600            | -1.07 | 143.2 | -25.76 | 26.4 | -0.18 | -1.0  | -3.94 | -170.4 |
| 1700            | -1.06 | 140.9 | -25.45 | 27.3 | -0.88 | -4.2  | -3.80 | -173.3 |
| 1800            | -1.08 | 138.5 | -24.92 | 25.4 | -1.52 | -10.5 | -3.44 | -175.9 |
| 1900            | -1.04 | 136.0 | -24.69 | 24.2 | -2.50 | -15.2 | -3.53 | -179.1 |
| 2000            | 11.00 | 133.6 | -23.92 | 26.2 | -2.65 | -16.6 | -3.26 | -178.6 |
| 2100            | -1.11 | 131.2 | -23.65 | 22.2 | -3.33 | -24.6 | -2.84 | -171.2 |
| 2200            | -1.12 | 129.0 | -23.19 | 21.1 | -3.80 | -28.7 | -2.75 | -168.7 |
| 2300            | -1.12 | 126.8 | -22.81 | 19.4 | -4.26 | -31.6 | -2.55 | -165.7 |
| 2400            | -1.11 | 124.4 | -22.52 | 19.5 | -4.88 | -35.4 | -2.56 | -163.1 |
| 2500            | -1.12 | 122.1 | -22.05 | 16.3 | -5.25 | -40.0 | -2.34 | -160.3 |
| 2600            | -1.13 | 119.7 | -21.65 | 15.5 | -5.63 | -42.7 | -2.24 | -156.8 |
| 2700            | -1.14 | 116.9 | -21.28 | 14.5 | -6.12 | -45.9 | -2.15 | -154.2 |
| 2800            | -0.96 | 116.2 | -20.93 | 12.3 | -6.43 | -49.2 | -2.03 | -151.8 |
| 2900            | -1.17 | 112.5 | -20.51 | 10.3 | -6.93 | -54.1 | -1.93 | -149.0 |
| 3000            | -1.20 | 109.9 | -20.11 | 8.8  | -7.41 | -56.3 | -1.82 | -146.2 |
| 3100            | -1.23 | 107.4 | -19.78 | 7.8  | -7.84 | -59.8 | -1.70 | -143.8 |
| 3200            | -1.28 | 104.8 | -19.38 | 3.9  | -8.08 | -64.3 | -1.64 | -140.9 |
| 3300            | -1.33 | 102.1 | -18.92 | 2.1  | -8.44 | -65.5 | -1.53 | -138.5 |
| 3400            | -1.38 | 99.5  | -18.60 | 1.1  | -8.78 | -69.0 | -1.46 | -135.8 |
| 3500            | -1.44 | 96.9  | -18.26 | -3.0 | -9.13 | -73.2 | -1.40 | -132.9 |

Figure 5. Common Emitter S-Parameters

The graph shown below displays MTTF in hours x ampere<sup>2</sup> emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  to the theoretical prediction for metal failure. Divide MTTF by  $I_C^2$  for MTTF in a particular application.

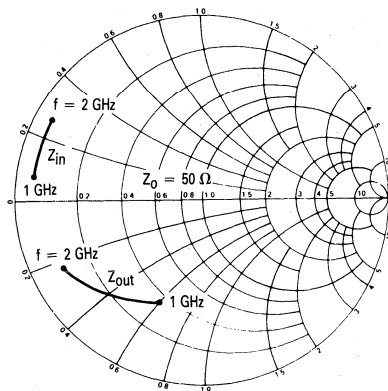


Figure 6. Series Equivalent Input/Output Impedance

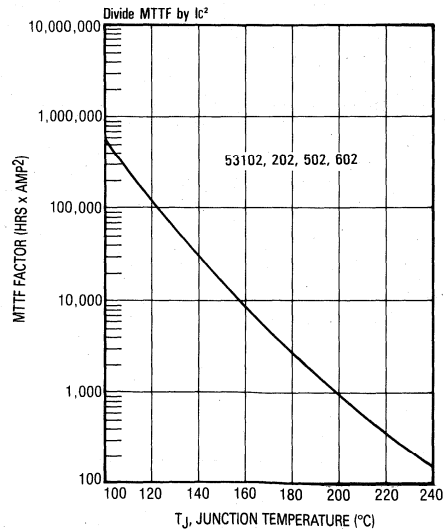


Figure 7. MTTF Factor versus Junction Temperature

**The RF Line**

**Microwave Linear  
Power Transistors**

2

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 2 GHz frequency range.

- Designed for Class A, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  - Output Power — 4 Watts
  - Power Gain — 6 to 7 dB, Min
- Hermetic Packages Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 22          | Vdc  |
| Collector-Base Voltage         | $V_{CES}$ | 50          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Collector Current — Continuous | $I_C$     | 2           | Adc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 10  | °C/W |

**ELECTRICAL CHARACTERISTICS** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                             |               |     |   |      |      |
|-----------------------------------------------------------------------------|---------------|-----|---|------|------|
| Collector-Emitter Breakdown Voltage ( $I_C = 50\text{ mA}$ , $I_B = 0$ )    | $V_{(BR)CEO}$ | 22  | — | —    | Vdc  |
| Collector-Emitter Breakdown Voltage ( $I_C = 50\text{ mA}$ , $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 50  | — | —    | Vdc  |
| Collector-Base Breakdown Voltage ( $I_C = 5\text{ mA}$ , $I_E = 0$ )        | $V_{(BR)CBO}$ | 45  | — | —    | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 1.25\text{ mA}$ , $I_C = 0$ )       | $V_{(BR)EBO}$ | 3.5 | — | —    | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 28\text{ V}$ , $I_E = 0$ )             | $I_{CBO}$     | —   | — | 1.25 | mAdc |

**ON CHARACTERISTICS**

|                                                                   |          |    |    |     |   |
|-------------------------------------------------------------------|----------|----|----|-----|---|
| DC Current Gain ( $I_C = 500\text{ mA}$ , $V_{CE} = 5\text{ V}$ ) | $h_{FE}$ | 20 | 35 | 120 | — |
|-------------------------------------------------------------------|----------|----|----|-----|---|

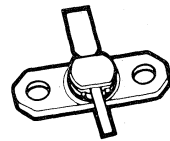
**DYNAMIC CHARACTERISTICS**

|                                                                                |          |   |   |    |    |
|--------------------------------------------------------------------------------|----------|---|---|----|----|
| Output Capacitance ( $V_{CB} = 28\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$ ) | $C_{ob}$ | — | 7 | 10 | pF |
|--------------------------------------------------------------------------------|----------|---|---|----|----|

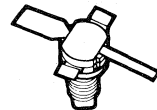
(continued)

**TRW53505**  
**TRW53605**

6 TO 7 dB  
 1-2 GHz  
 4 WATTS  
 MICROWAVE  
 LINEAR POWER  
 TRANSISTORS



GP-13  
 CASE 328F-01, STYLE 1  
 TRW53605



GP-14S  
 CASE 401-01, STYLE 1  
 TRW53505

# TRW53505, TRW53605

## ELECTRICAL CHARACTERISTICS — continued ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

| Characteristic                                                                                                      | Symbol               | Min                               | Typ    | Max    | Unit   |     |
|---------------------------------------------------------------------------------------------------------------------|----------------------|-----------------------------------|--------|--------|--------|-----|
| FUNCTIONAL TESTS                                                                                                    |                      |                                   |        |        |        |     |
| Common-Emitter Amplifier Power Gain<br>(VCE = 20 V, Pout = 4 W, f = 2 GHz, IE = 600 mA)                             | TRW53605<br>TRW53505 | GPE                               | 7<br>6 | —<br>— | —<br>— | dB  |
| Load Mismatch<br>(VCE = 20 V, Pout = 4 W, f = 2 GHz,<br>Load VSWR = 3:1, All Phase Angles)                          | ψ                    | No Degradation in<br>Output Power |        |        |        |     |
| Cutoff Frequency (Basic cell design)                                                                                | fT                   | —                                 | 3      | —      | —      | GHz |
| Intermodulation Distortion, 3rd Order<br>(VCE = 20 V, IE = 600 mA, PO (PEP) = 2 W,<br>Tones at 2 GHz and 2.005 GHz) | IMD                  | —                                 | −30    | —      | —      | dB  |

## TYPICAL CHARACTERISTICS

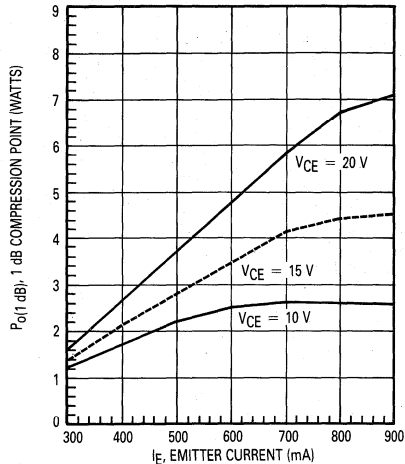


Figure 1. 1 dB Compression Point versus Emitter Current @ 2 GHz

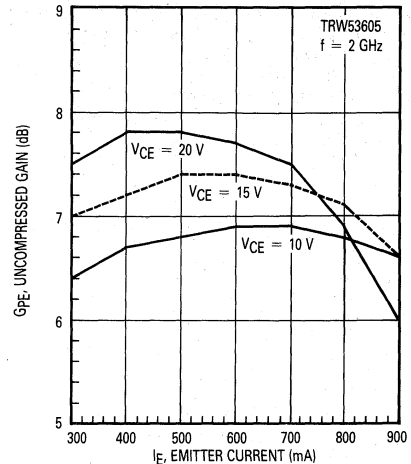


Figure 2. Uncompressed Gain versus Emitter Current

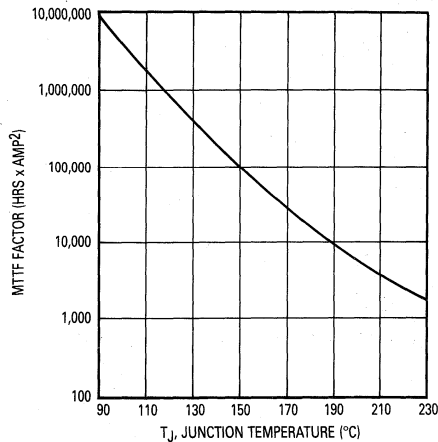


Figure 3. MTTF Factor versus Junction Temperature

The graph shown below displays MTTF in hours x ampere<sup>2</sup> emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  to the theoretical prediction for metal failure. Divide MTTF by  $I_C^2$  for MTTF in a particular application.

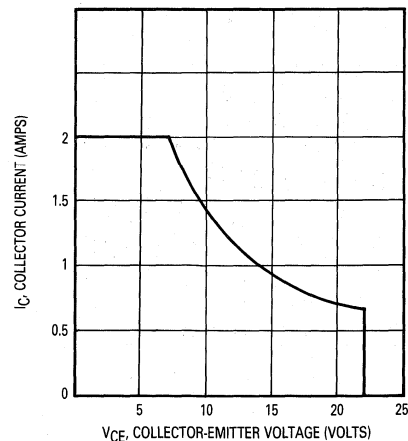


Figure 4. DC Safe Operating Area

## TRW53605

V<sub>CE</sub> = 20V  
I<sub>C</sub> = 500mA

| Frequency (MHz) | S11   |       | S12    |       | S21    |       | S22   |        |
|-----------------|-------|-------|--------|-------|--------|-------|-------|--------|
|                 | dB    | Angle | dB     | Angle | dB     | Angle | dB    | Angle  |
| 400             | -0.58 | 175.3 | -30.68 | 13.5  | 8.18   | 73.6  | -3.61 | -176.5 |
| 500             | -0.52 | 172.2 | -30.66 | 13.5  | 6.48   | 67.7  | -3.63 | -179.4 |
| 600             | -0.46 | 170.9 | -30.38 | 15.7  | 4.68   | 63.0  | -3.47 | 179.2  |
| 700             | -0.82 | 169.6 | -30.05 | 17.0  | 2.98   | 55.9  | -3.40 | 176.5  |
| 800             | -1.07 | 165.0 | -29.84 | 18.6  | 1.92   | 48.2  | -3.32 | 175.8  |
| 900             | -0.71 | 162.8 | -29.43 | 18.8  | 1.03   | 44.1  | -3.21 | 172.1  |
| 1000            | -0.71 | 160.7 | -29.10 | 19.1  | 0.06   | 38.6  | -3.17 | 170.7  |
| 1100            | -0.73 | 158.6 | -28.79 | 20.5  | -0.87  | 34.2  | -9.95 | 167.7  |
| 1200            | -0.75 | 156.7 | -28.54 | 20.0  | -1.70  | 28.5  | -2.96 | 166.2  |
| 1300            | -0.75 | 154.8 | -28.12 | 21.0  | -2.44  | 24.6  | -2.69 | 164.4  |
| 1400            | -0.76 | 152.9 | -27.81 | 21.7  | -3.16  | 20.5  | -2.71 | 162.4  |
| 1500            | -0.97 | 151.9 | -27.51 | 21.4  | -4.04  | 16.5  | -2.53 | 161.3  |
| 1600            | -0.76 | 149.2 | -27.09 | 20.1  | -4.41  | 11.0  | -2.54 | 158.4  |
| 1700            | -0.74 | 147.3 | -26.77 | 20.5  | -4.99  | 6.6   | -2.43 | 156.8  |
| 1800            | -0.72 | 145.4 | -26.48 | 21.1  | -5.63  | 4.0   | -2.27 | 153.8  |
| 1900            | -0.72 | 143.5 | -26.36 | 19.5  | -6.18  | -1.6  | -2.41 | 152.1  |
| 2000            | -0.75 | 141.5 | -25.69 | 19.0  | -6.53  | -5.0  | -2.00 | 150.0  |
| 2100            | -0.67 | 138.8 | -25.57 | 20.2  | -7.04  | -7.9  | -2.14 | 148.0  |
| 2200            | -0.65 | 137.0 | -25.27 | 18.7  | -7.74  | -12.1 | -1.95 | 146.2  |
| 2300            | -0.64 | 135.1 | -25.03 | 17.5  | -8.04  | -16.4 | -1.97 | 143.6  |
| 2400            | -0.63 | 133.2 | -24.57 | 16.9  | -8.47  | -19.1 | -1.88 | 141.9  |
| 2500            | -0.63 | 131.4 | -24.39 | 17.7  | -8.91  | -21.0 | -1.78 | 139.8  |
| 2600            | -0.63 | 129.5 | -24.10 | 15.4  | -9.34  | -24.1 | -1.74 | 137.6  |
| 2700            | -0.63 | 127.6 | -23.72 | 13.8  | -9.63  | -29.9 | -1.66 | 135.8  |
| 2800            | -0.64 | 125.8 | -23.37 | 14.3  | -10.09 | -31.2 | -1.59 | 133.8  |
| 2900            | -0.64 | 124.0 | -23.15 | 13.1  | -10.57 | -34.2 | -1.55 | 131.5  |
| 3000            | -0.64 | 121.8 | -22.70 | 11.2  | -10.87 | -38.2 | -1.33 | 129.5  |
| 3100            | -0.45 | 121.5 | -22.34 | 9.2   | -10.89 | -38.9 | -1.40 | 127.1  |
| 3200            | -0.67 | 118.4 | -22.04 | 10.0  | -11.50 | -42.1 | -1.24 | 126.1  |
| 3300            | -0.70 | 116.6 | -21.82 | 6.3   | -11.86 | -45.2 | -1.18 | 122.4  |
| 3400            | -0.71 | 114.8 | -21.52 | 4.8   | -12.03 | -48.8 | -1.14 | 121.7  |

Figure 5. Common Emitter S-Parameters

**The RF Line**

**Microwave Linear Power Transistors**

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 4 GHz frequency range.

- Designed for Class A, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  - Output Power — 0.5 Watt
  - Power Gain — 10 to 11 dB
- 100% Tested for Load Mismatch at All Phase Angles with  $\infty:1$  VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 22          | Vdc  |
| Collector-Base Voltage         | $V_{CES}$ | 50          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 40  | °C/W |

**ELECTRICAL CHARACTERISTICS**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                        |               |     |   |      |                  |
|------------------------------------------------------------------------|---------------|-----|---|------|------------------|
| Collector-Emitter Breakdown Voltage<br>( $I_C = 10$ mA, $I_E = 0$ )    | $V_{(BR)CEO}$ | 22  | — | —    | Vdc              |
| Collector-Emitter Breakdown Voltage<br>( $I_C = 10$ mA, $V_{BE} = 0$ ) | $V_{(BR)CES}$ | 50  | — | —    | Vdc              |
| Collector-Base Breakdown Voltage<br>( $I_C = 1$ mA, $I_E = 0$ )        | $V_{(BR)CBO}$ | 45  | — | —    | Vdc              |
| Emitter-Base Breakdown Voltage<br>( $I_E = 0.25$ mA, $I_C = 0$ )       | $V_{(BR)EBO}$ | 3.5 | — | —    | Vdc              |
| Collector Cutoff Current ( $V_{CB} = 28$ V, $I_E = 0$ )                | $I_{CBO}$     | —   | — | 0.25 | mA <sub>dc</sub> |

**ON CHARACTERISTICS**

|                                                   |          |    |   |     |   |
|---------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 100$ mA, $V_{CE} = 5$ V) | $h_{FE}$ | 20 | — | 120 | — |
|---------------------------------------------------|----------|----|---|-----|---|

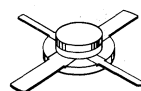
**DYNAMIC CHARACTERISTICS**

|                                                                   |          |   |   |     |    |
|-------------------------------------------------------------------|----------|---|---|-----|----|
| Output Capacitance<br>( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | — | 3.5 | pF |
|-------------------------------------------------------------------|----------|---|---|-----|----|

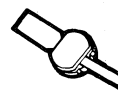
(continued)

**TRW54001 Series**

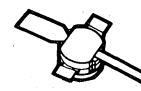
10 TO 11 dB  
 1-4 GHz  
 0.5 WATT  
**MICROWAVE  
 LINEAR POWER  
 TRANSISTORS**



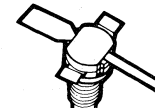
GP-14  
 CASE 400-01, STYLE 1  
 TRW54001



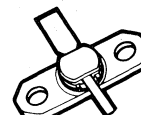
GP-13F  
 CASE 328E-01, STYLE 2  
 TRW54101



GP-14S  
 CASE 401A-01, STYLE 1  
 TRW54201



TW200  
 CASE 400-01, STYLE 1  
 TRW54501



GP-13  
 CASE 328F-01, STYLE 1  
 TRW54601



## ELECTRICAL CHARACTERISTICS — continued

| Characteristic                                                                                                                                                     | Symbol                           | Min                            | Typ | Max        | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|--------------------------------|-----|------------|------|
| <b>FUNCTIONAL TESTS</b>                                                                                                                                            |                                  |                                |     |            |      |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 0.5\text{ W}$ , $f = 2\text{ GHz}$ , $I_E = 120\text{ mA}$ )                          | TRW54001<br>TRW54201<br>TRW54501 | GPE                            | 10  | —          | dB   |
| Common-Emitter Amplifier Power Gain<br>( $V_{CE} = 20\text{ V}$ , $P_{out} = 0.5\text{ W}$ , $f = 2\text{ GHz}$ , $I_E = 120\text{ mA}$ )                          | TRW54101<br>TRW54601             | GPE                            | 11  | —          | dB   |
| Load Mismatch<br>( $V_{CE} = 20\text{ V}$ , $I_E = 120\text{ mA}$ , $P_{out} = 0.5\text{ W}$ , $f = 2\text{ GHz}$ ,<br>Load VSWR = $\infty:1$ , All Phase Angles)  | $\psi$                           | No Degradation in Output Power |     |            |      |
| Cutoff Frequency ( $V_{CE} = 20\text{ V}$ , $I_E = 120\text{ mA}$ )                                                                                                | $f_T$                            | 4                              | 4.5 | —          | GHz  |
| Gain Linearity<br>( $V_{CE} = 20\text{ V}$ , $I_E = 120\text{ mA}$ , $f = 2\text{ GHz}$ ,<br>$P_{O1} = 0.5\text{ W}$ , $P_{O2} = 0.5\text{ mW}$ )                  | $L_G$                            | —                              | —   | -0.2<br>+1 | dB   |
| Intermodulation Distortion, 3rd Order<br>( $V_{CE} = 20\text{ V}$ , $I_E = 120\text{ mA}$ , $P_{OP}(\text{PEP}) = 0.5\text{ W}$ ,<br>Tones at 2 GHz and 2.005 GHz) | IMD                              | —                              | -30 | —          | dB   |
| Intermodulation Distortion (DIN-45004/K)<br>( $V_{CE} = 20\text{ V}$ , $I_E = 75\text{ mA}$ , $f = 1\text{ GHz}$ , $P_{ref} = 0.15\text{ W}$ )                     | IMD (TV)                         | —                              | -60 | —          | dB   |

## TYPICAL CHARACTERISTICS

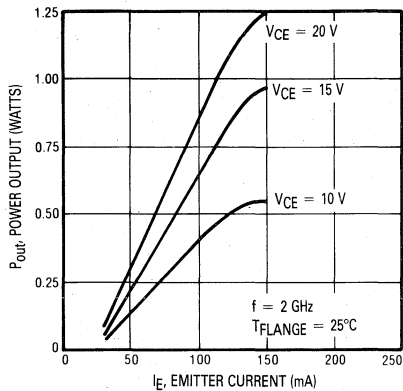


Figure 1. 1 dB Compression Point versus Emitter Current

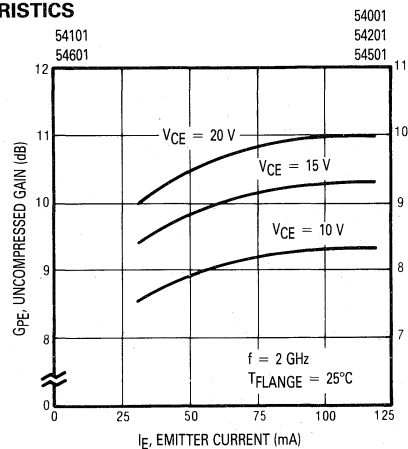


Figure 2. Gain versus Emitter Current

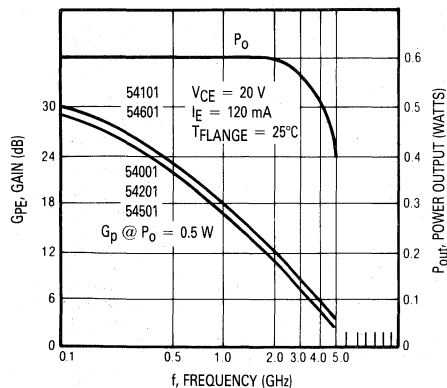


Figure 3. Gain and 1 dB Compressed Power versus Frequency

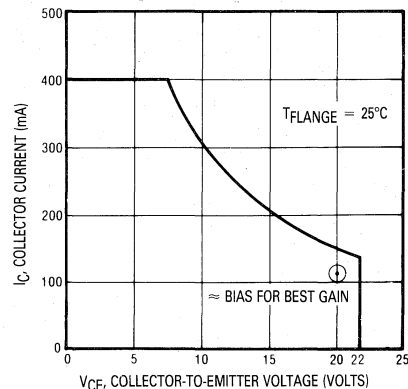


Figure 4. DC Safe Operating Area

## TRW54101/601

V<sub>CE</sub> = 20V  
I<sub>c</sub> = 100mA

| Frequency (MHz) | S11   |        | S12    |      | S21   |       | S22    |        |
|-----------------|-------|--------|--------|------|-------|-------|--------|--------|
|                 | dB    | Ang    | dB     | Ang  | dB    | Ang   | dB     | Ang    |
| 400             | -2.44 | -171.1 | -29.40 | 30.0 | 17.54 | 89.3  | -9.11  | -55.5  |
| 500             | -2.29 | -177.9 | -29.06 | 31.9 | 15.80 | 83.7  | -9.83  | -57.1  |
| 600             | -2.21 | 176.7  | -28.62 | 32.2 | 14.32 | 77.2  | -10.42 | -60.3  |
| 700             | -2.16 | 171.8  | -28.26 | 33.4 | 13.02 | 71.1  | -10.74 | -62.6  |
| 800             | -2.12 | 167.4  | -27.85 | 35.0 | 11.81 | 66.3  | -10.89 | -67.3  |
| 900             | -2.06 | 163.3  | -27.45 | 36.6 | 10.78 | 61.2  | -11.04 | -70.8  |
| 1000            | -2.03 | 159.3  | -26.87 | 38.1 | 9.86  | 56.4  | -10.97 | -74.5  |
| 1100            | -1.98 | 155.7  | -26.49 | 39.2 | 8.98  | 52.0  | -10.99 | -79.3  |
| 1200            | -1.93 | 152.4  | -25.95 | 40.1 | 8.30  | 47.5  | -10.89 | -83.3  |
| 1300            | -1.90 | 149.3  | -25.50 | 40.7 | 7.60  | 43.5  | -10.73 | -88.3  |
| 1400            | -1.96 | 147.1  | -25.07 | 42.2 | 6.78  | 40.6  | -10.62 | -93.3  |
| 1500            | -1.81 | 143.6  | -24.67 | 41.0 | 6.26  | 34.3  | -10.41 | -97.7  |
| 1600            | -1.79 | 140.8  | -24.20 | 41.9 | 5.66  | 30.8  | -10.22 | -103.4 |
| 1700            | -1.75 | 137.9  | -23.79 | 42.5 | 5.13  | 27.9  | -10.03 | -107.6 |
| 1800            | -1.72 | 135.2  | -23.42 | 41.9 | 4.46  | 22.7  | -9.66  | -112.7 |
| 1900            | -1.65 | 132.7  | -22.94 | 41.9 | 4.13  | 19.4  | -9.48  | -117.8 |
| 2000            | -1.58 | 130.2  | -22.47 | 41.8 | 3.63  | 16.3  | -9.15  | -121.3 |
| 2100            | -1.54 | 130.7  | -22.00 | 43.1 | 3.05  | 13.2  | -8.83  | -126.3 |
| 2200            | -1.50 | 128.6  | -21.52 | 41.8 | 2.66  | 9.0   | -8.70  | -129.9 |
| 2300            | -1.43 | 126.5  | -21.16 | 41.4 | 2.23  | 6.5   | -8.28  | -135.2 |
| 2400            | -1.39 | 124.4  | -20.78 | 41.9 | 1.67  | 4.0   | -8.09  | -139.1 |
| 2500            | -1.34 | 122.5  | -20.43 | 39.3 | 1.36  | -1.0  | -7.71  | -142.4 |
| 2600            | -1.29 | 120.4  | -19.96 | 38.8 | 1.02  | -3.3  | -7.55  | -147.6 |
| 2700            | -1.23 | 118.7  | -19.58 | 39.3 | 0.51  | -5.3  | -7.28  | -150.2 |
| 2800            | -1.14 | 117.1  | -19.37 | 37.5 | 0.07  | -9.3  | -6.92  | -154.8 |
| 2900            | -1.08 | 114.9  | -18.87 | 35.5 | -0.21 | -13.4 | -6.70  | -158.6 |
| 3000            | -0.97 | 112.7  | -18.54 | 35.4 | -0.32 | -15.9 | -6.35  | -162.0 |
| 3100            | -1.13 | 109.5  | -18.24 | 34.9 | -1.02 | -18.7 | -6.13  | -165.8 |
| 3200            | -1.07 | 107.5  | -17.89 | 31.5 | -1.29 | -23.7 | -5.85  | -168.7 |
| 3300            | -1.04 | 105.3  | -17.46 | 30.8 | -1.57 | -24.9 | -5.49  | -172.4 |
| 3400            | -0.94 | 103.9  | -17.22 | 30.5 | -2.04 | -27.6 | -5.20  | -175.4 |
| 3500            | -0.82 | 101.5  | -16.97 | 26.8 | -2.33 | -31.2 | -4.84  | -178.1 |
| 3600            | -0.75 | 99.7   | -16.65 | 24.4 | -2.65 | -34.1 | -4.70  | -177.8 |
| 3700            | -0.64 | 97.9   | -16.44 | 24.8 | -3.04 | -34.9 | -4.51  | -175.6 |
| 3800            | -1.03 | 93.8   | -16.18 | 22.3 | -3.54 | -39.8 | -4.08  | -171.6 |
| 3900            | -1.13 | 91.7   | -16.05 | 19.0 | -4.03 | -42.3 | -4.13  | -169.0 |
| 4000            | -1.01 | 89.7   | -15.62 | 18.7 | -4.22 | -44.0 | -3.67  | -166.4 |

## TRW54001

V<sub>CE</sub> = 20V  
I<sub>c</sub> = 100mA

| Frequency (MHz) | S11   |        | S12    |       | S21   |        | S22   |        |
|-----------------|-------|--------|--------|-------|-------|--------|-------|--------|
|                 | dB    | Ang    | dB     | Ang   | dB    | Ang    | dB    | Ang    |
| 400             | -2.57 | -169.2 | -31.03 | 21.3  | 18.30 | 81.2   | -7.20 | -67.0  |
| 500             | -2.43 | -176.5 | -30.73 | 20.3  | 16.46 | 73.5   | -7.25 | -72.5  |
| 600             | -2.40 | 177.6  | -30.54 | 20.3  | 14.87 | 65.2   | -7.25 | -79.0  |
| 700             | -2.37 | 172.5  | -30.25 | 20.7  | 13.56 | 58.1   | -7.02 | -85.1  |
| 800             | -2.36 | 168.1  | -30.01 | 21.1  | 12.34 | 51.6   | -6.70 | -91.8  |
| 900             | -2.35 | 163.3  | -29.75 | 23.2  | 11.12 | 44.1   | -6.35 | -97.9  |
| 1000            | -2.40 | 159.1  | -29.32 | 23.8  | 10.20 | 38.7   | -6.03 | -103.5 |
| 1100            | -2.39 | 155.1  | -29.00 | 24.3  | 9.27  | 32.2   | -5.73 | -109.2 |
| 1200            | -2.36 | 151.4  | -28.46 | 24.3  | 8.52  | 26.2   | -5.38 | -114.8 |
| 1300            | -2.37 | 147.7  | -28.05 | 24.7  | 7.83  | 20.6   | -5.04 | -120.0 |
| 1400            | -2.36 | 144.1  | -27.67 | 25.4  | 6.95  | 15.0   | -4.71 | -125.3 |
| 1500            | -2.45 | 141.3  | -27.26 | 23.9  | 6.31  | 9.3    | -4.44 | -130.1 |
| 1600            | -2.37 | 137.5  | -26.72 | 24.1  | 5.71  | 3.3    | -4.10 | -135.8 |
| 1700            | -2.40 | 134.2  | -26.41 | 24.2  | 5.10  | -0.8   | -3.92 | -140.4 |
| 1800            | -2.43 | 130.8  | -25.86 | 22.3  | 4.54  | -7.7   | -3.56 | -144.6 |
| 1900            | -2.39 | 127.5  | -25.54 | 20.1  | 4.16  | -12.8  | -3.54 | -150.8 |
| 2000            | -2.38 | 124.2  | -24.90 | 22.3  | 3.57  | -14.4  | -3.34 | -151.5 |
| 2100            | -2.52 | 119.7  | -24.73 | 16.5  | 2.85  | -23.9  | -2.95 | -159.7 |
| 2200            | -2.55 | 116.4  | -24.34 | 14.9  | 2.43  | -29.1  | -2.91 | -162.8 |
| 2300            | -2.61 | 112.9  | -23.88 | 12.8  | 2.05  | -32.8  | -2.62 | -166.6 |
| 2400            | -2.67 | 109.2  | -23.66 | 11.8  | 1.50  | -37.5  | -2.62 | -169.9 |
| 2500            | -2.72 | 105.7  | -23.18 | 8.6   | 1.20  | -43.4  | -2.39 | -172.9 |
| 2600            | -2.80 | 101.8  | -22.82 | 6.3   | 0.90  | -47.2  | -2.32 | -177.6 |
| 2700            | -2.90 | 97.5   | -22.53 | 4.8   | 0.50  | -51.7  | -2.24 | -179.4 |
| 2800            | -2.82 | 94.5   | -22.18 | 1.7   | 0.34  | -57.0  | -2.03 | -176.3 |
| 2900            | -3.12 | 89.7   | -21.80 | -1.3  | -0.09 | -62.7  | -1.93 | -173.3 |
| 3000            | -3.26 | 85.1   | -21.46 | -4.0  | -0.48 | -66.7  | -1.77 | -170.1 |
| 3100            | -3.41 | 80.6   | -21.25 | -6.2  | -0.84 | -71.7  | -1.71 | -167.2 |
| 3200            | -3.60 | 75.8   | -20.89 | -11.1 | -1.01 | -77.9  | -1.58 | -164.2 |
| 3300            | -3.82 | 70.6   | -20.53 | -13.8 | -1.30 | -81.3  | -1.41 | -161.0 |
| 3400            | -4.05 | 65.4   | -20.27 | -16.6 | -1.56 | -86.6  | -1.33 | -158.1 |
| 3500            | -4.30 | 59.5   | -20.06 | -21.6 | -1.81 | -93.6  | -1.18 | -154.7 |
| 3600            | -4.57 | 53.3   | -19.69 | -26.0 | -2.03 | -97.6  | -1.07 | -151.5 |
| 3700            | -4.86 | 47.1   | -19.65 | -29.7 | -2.32 | -102.8 | -1.02 | -149.0 |
| 3800            | -5.18 | 39.9   | -19.37 | -34.0 | -2.60 | -108.6 | -0.20 | -146.3 |
| 3900            | -5.54 | 32.4   | -19.20 | -41.0 | -2.75 | -114.3 | -0.79 | -142.8 |
| 4000            | -5.92 | 24.4   | -19.16 | -44.0 | -3.05 | -119.4 | -0.69 | -140.6 |

Figure 5. Common Emitter S-Parameters

The graph shown below displays MTTF in hours x ampere<sup>2</sup> emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  to the theoretical prediction for metal failure. Divide MTTF by  $I_C^2$  for MTTF in a particular application.

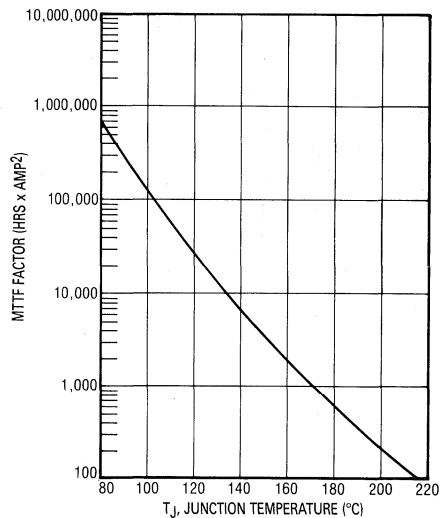


Figure 6. MTTF Factor versus Junction Temperature

**TRW62601**

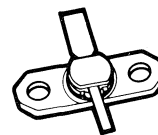
**The RF Line**

**Microwave Power  
Oscillator Transistor**

... designed for use as power oscillators at frequencies to 3 GHz with typical output power of over 1 watt.

- Operation to 3 GHz
- High Output Power (1.2 W Typ @ 2.5 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistors
- Common Collector Configuration

**MICROWAVE  
POWER  
OSCILLATOR  
TRANSISTOR**



GP-13  
CASE 328F-01, STYLE 3

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 22          | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 45          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Collector Current — Continuous | $I_C$     | 0.5         | Adc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 15  | °C/W |

**ELECTRICAL CHARACTERISTICS**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                               |               |     |   |       |      |
|-------------------------------------------------------------------------------|---------------|-----|---|-------|------|
| Collector-Emitter Breakdown Voltage ( $I_C = 20$ mA, $I_B = 0$ )              | $V_{(BR)CEO}$ | 22  | — | —     | Vdc  |
| Collector-Base Breakdown Voltage ( $I_C = 1$ mA, $I_E = 0$ )                  | $V_{(BR)CBO}$ | 45  | — | —     | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 0.25$ mA, $I_C = 0$ )                 | $V_{(BR)EBO}$ | 3.5 | — | —     | Vdc  |
| Collector-Emitter Breakdown Voltage ( $I_C = 20$ mA, $R_{BE} = 10$ $\Omega$ ) | $V_{(BR)CER}$ | 50  | — | —     | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 28$ V, $I_E = 0$ )                       | $I_{CBO}$     | —   | — | 0.125 | mAdc |

**ON CHARACTERISTICS**

|                                                   |          |    |   |     |   |
|---------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 100$ mA, $V_{CE} = 5$ V) | $h_{FE}$ | 20 | — | 120 | — |
|---------------------------------------------------|----------|----|---|-----|---|

**DYNAMIC CHARACTERISTICS**

|                                                                |          |   |   |   |    |
|----------------------------------------------------------------|----------|---|---|---|----|
| Output Capacitance ( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | — | 5 | pF |
|----------------------------------------------------------------|----------|---|---|---|----|

(continued)

ELECTRICAL CHARACTERISTICS — continued

| Characteristic                                                                                                                     | Symbol    | Min                            | Typ | Max | Unit |
|------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------------|-----|-----|------|
| <b>FUNCTIONAL TESTS</b>                                                                                                            |           |                                |     |     |      |
| Oscillator Output Power ( $V_{CE} = 20$ V, $f = 2$ GHz, $I_E = 220$ mA)                                                            | $P_{out}$ | 1.25                           | —   | —   | W    |
| Load Mismatch<br>( $V_{CE} = 20$ V, $I_E = 220$ mA, $P_{out} = 1.25$ W, $f = 2$ GHz,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$    | No Degradation in Output Power |     |     |      |
| Cutoff Frequency ( $V_{CE} = 20$ V, $I_E = 220$ mA)                                                                                | $f_T$     | —                              | 2.7 | —   | GHz  |

TYPICAL CHARACTERISTICS

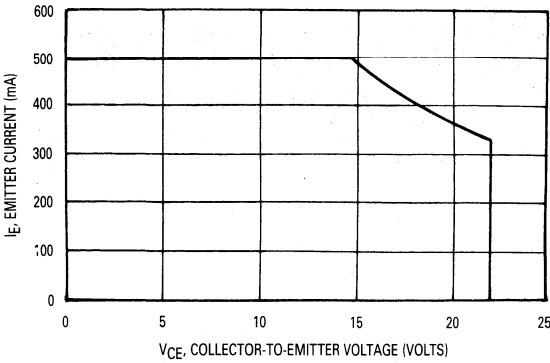


Figure 1. DC Safe Operating Area

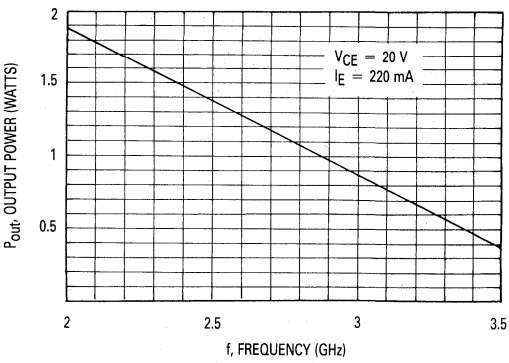


Figure 2. Output Power versus Frequency

- C1 — 220 pF (chip)
- C2 — 220 pF (chip) + 10 nF
- C3 — 220 pF (chip) + 10 nF + 10  $\mu$ F
- C4 — 0.6–4.5 pF (Frequency tuning)
- L — adjust to obtain the maximum output power
- $\theta = 0.115 \lambda g$  for  $f_0 = 2.3$  GHz
- $\theta = 0.06 \lambda g$  for  $f_0 = 3$  GHz

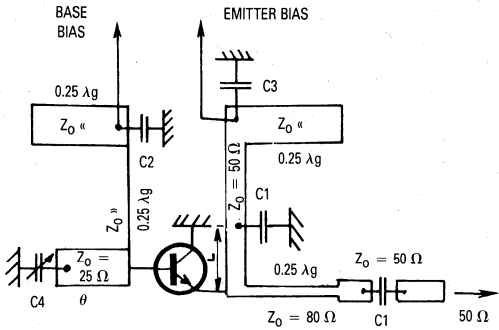
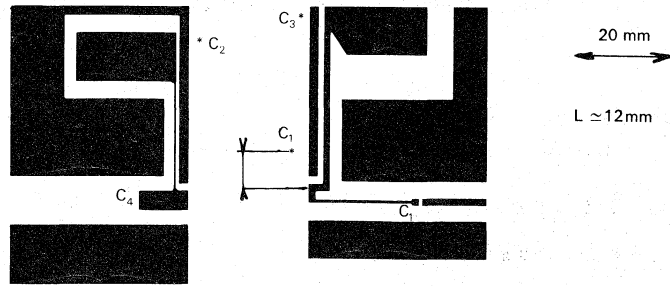
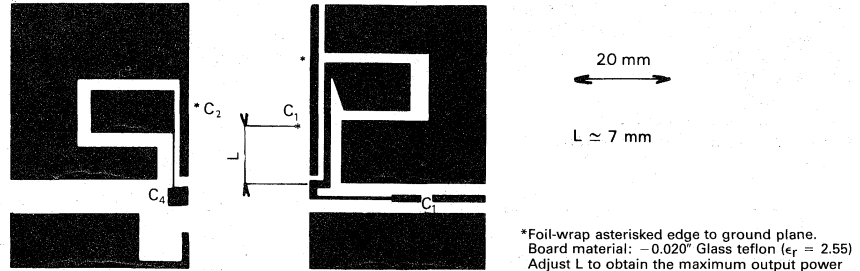
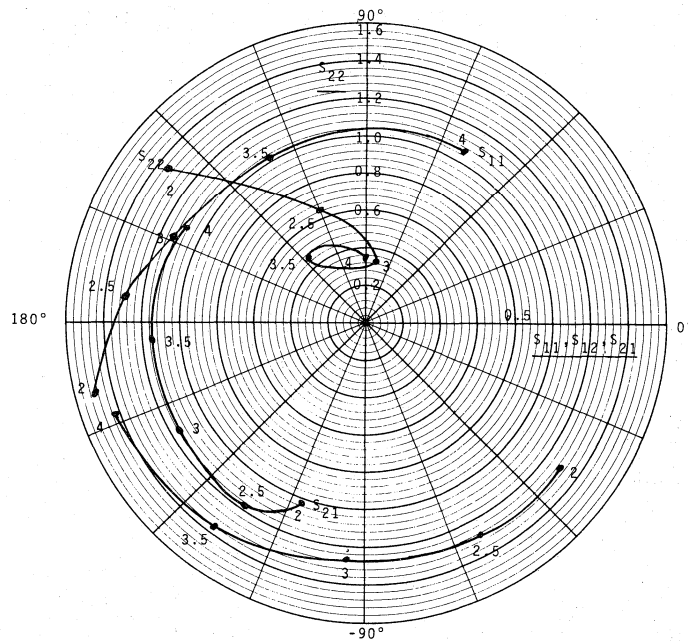


Figure 3. Test Circuit

Figure 4. PC Board Layout for  $f_0 = 2.3$  GHz (BW = 500 MHz)Figure 5. PC Board Layout for  $f_0 = 3$  GHz (BW = 500 MHz)

## TYPICAL CHARACTERISTICS

Figure 6. Small Signal S-Parameters  
( $V_{CE} = 20$  V,  $I_E = 220$  mA)

**The RF Line**

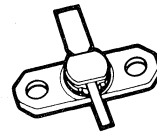
**Microwave Power  
Oscillator Transistor**

... designed for use as power oscillators at frequencies to 3 GHz with guaranteed output power of 2.5 W @ 2 GHz.

- Operation to 3 GHz
- High Output Power (2 W Typ @ 2.5 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistors
- Common Collector Configuration

**TRW62602**

**MICROWAVE  
POWER  
OSCILLATOR  
TRANSISTOR**



**GP-13  
CASE 328F-01, STYLE 3**

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 22          | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 45          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 8.5 | °C/W |

**ELECTRICAL CHARACTERISTICS**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                       |               |     |   |      |                  |
|-----------------------------------------------------------------------|---------------|-----|---|------|------------------|
| Collector-Emitter Breakdown Voltage ( $I_C = 40$ mA, $I_B = 0$ )      | $V_{(BR)CEO}$ | 22  | — | —    | Vdc              |
| Collector-Base Breakdown Voltage ( $I_C = 2$ mA, $I_E = 0$ )          | $V_{(BR)CBO}$ | 45  | — | —    | Vdc              |
| Emitter-Base Breakdown Voltage ( $I_E = 0.5$ mA, $I_C = 0$ )          | $V_{(BR)EBO}$ | 3.5 | — | —    | Vdc              |
| Collector Cutoff Current ( $V_{CB} = 28$ V, $I_E = 0$ )               | $I_{CBO}$     | —   | — | 0.25 | mA <sub>dc</sub> |
| Collector-Emitter Breakdown Voltage ( $I_C = 40$ mA, $R_{BE} = 10$ Ω) | $V_{(BR)CER}$ | 50  | — | —    | Vdc              |

**ON CHARACTERISTICS**

|                                                   |          |    |   |     |   |
|---------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 200$ mA, $V_{CE} = 5$ V) | $h_{FE}$ | 20 | — | 120 | — |
|---------------------------------------------------|----------|----|---|-----|---|

**DYNAMIC CHARACTERISTICS**

|                                                                |          |   |   |   |    |
|----------------------------------------------------------------|----------|---|---|---|----|
| Output Capacitance ( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | — | 7 | pF |
|----------------------------------------------------------------|----------|---|---|---|----|

**FUNCTIONAL TESTS**

|                                                                                                                           |           |                                   |     |   |     |
|---------------------------------------------------------------------------------------------------------------------------|-----------|-----------------------------------|-----|---|-----|
| Oscillator Output Power ( $V_{CE} = 20$ V, $f = 2$ GHz, $I_E = 440$ mA)                                                   | $P_{out}$ | 2.5                               | —   | — | W   |
| Load Mismatch<br>( $V_{CE} = 20$ V, $I_E = 440$ mA, $P_{out} = 2.5$ W, $f = 2$ GHz,<br>Load VSWR = ∞:1, All Phase Angles) | $\psi$    | No Degradation in<br>Output Power |     |   |     |
| Cutoff Frequency ( $V_{CE} = 20$ V, $I_E = 440$ mA)                                                                       | $f_T$     | —                                 | 2.7 | — | GHz |

## TYPICAL CHARACTERISTICS

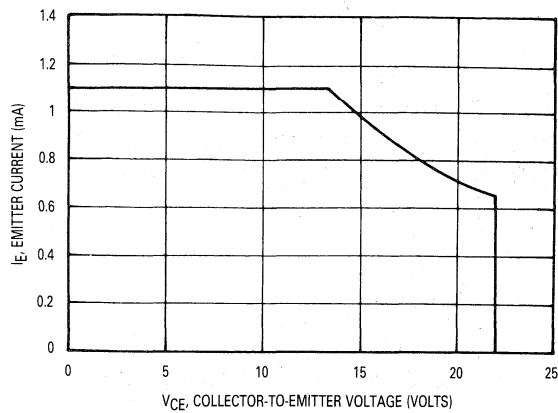


Figure 1. DC Safe Operating Area

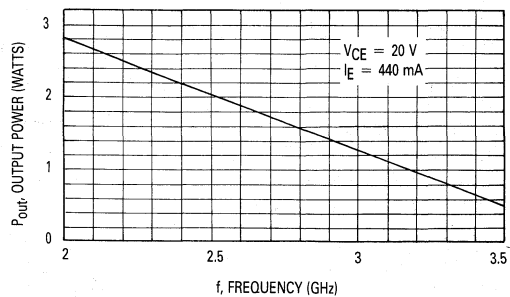
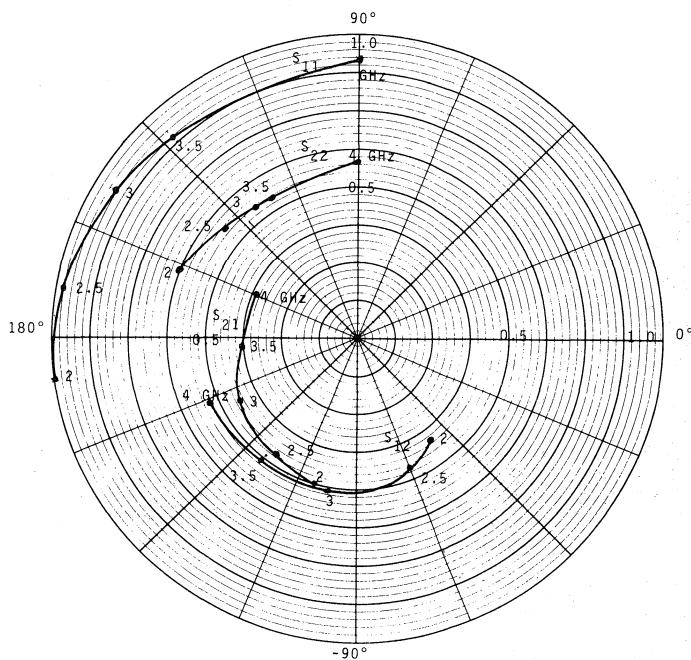


Figure 2. Output Power versus Frequency

Figure 3. Small Signal S-Parameters  
( $V_{CE} = 20$  V,  $I_E = 440$  mA)



C1 — 220 pF (chip)  
 C2 — 220 pF (chip) + 10 nF  
 C3 — 220 pF (chip) + 10 nF + 10  $\mu$ F  
 C4 — 0.6–4.5 pF (Frequency tuning)

L — adjust to obtain the maximum output power

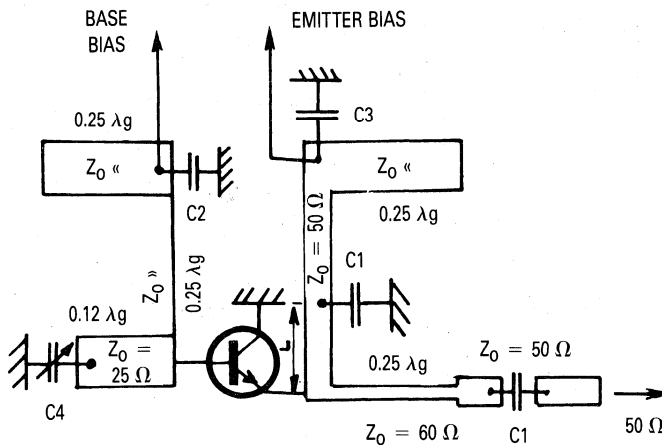
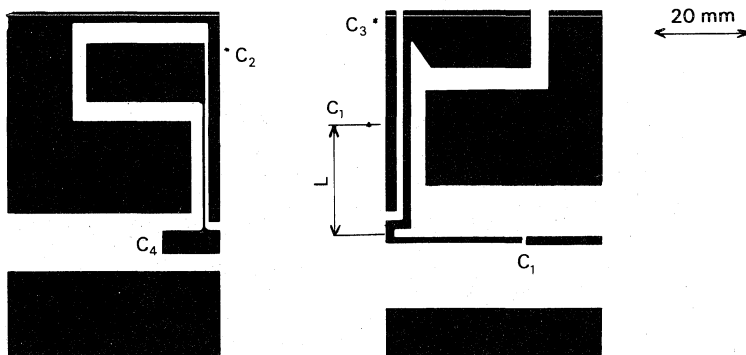


Figure 4. Test Circuit



\*Foil-wrap asterisked edge to ground plane.  
 Board material: -0.020" Glass teflon ( $\epsilon_r = 2.55$ )  
 Adjust L to obtain the maximum output power

For  $f = 2$  GHz  $L = 24$  mm  
 $f = 2.3$  GHz  $L = 19$  mm  
 $f = 2.5$  GHz  $L = 14$  mm

Figure 5. PC Board Layout for  $f_0 = 2.3$  GHz (BW = 500 MHz)

**TRW63601**

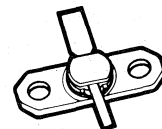
**The RF Line**

**Microwave Power  
Oscillator Transistor**

... designed for use as power oscillators at frequencies to 3.5 GHz with guaranteed output power of 0.6 W @ 2.3 GHz.

- Operation to 3.5 GHz
- High Output Power (0.43 W Typ @ 3 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistor
- Common Collector Configuration

**MICROWAVE  
POWER  
OSCILLATOR  
TRANSISTOR**



**GP-13  
CASE 328F-01, STYLE 3**

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 20          | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 45          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 32  | °C/W |

**ELECTRICAL CHARACTERISTICS**

| Characteristic                                                                | Symbol        | Min | Typ | Max  | Unit             |
|-------------------------------------------------------------------------------|---------------|-----|-----|------|------------------|
| <b>OFF CHARACTERISTICS</b>                                                    |               |     |     |      |                  |
| Collector-Emitter Breakdown Voltage ( $I_C = 10$ mA, $I_B = 0$ )              | $V_{(BR)CEO}$ | 20  | —   | —    | Vdc              |
| Collector-Base Breakdown Voltage ( $I_C = 1$ mA, $I_E = 0$ )                  | $V_{(BR)CBO}$ | 45  | —   | —    | Vdc              |
| Emitter-Base Breakdown Voltage ( $I_E = 0.25$ mA, $I_C = 0$ )                 | $V_{(BR)EBO}$ | 3.5 | —   | —    | Vdc              |
| Collector-Emitter Breakdown Voltage ( $I_C = 10$ mA, $R_{BE} = 10$ $\Omega$ ) | $V_{(BR)CER}$ | 50  | —   | —    | Vdc              |
| Collector Cutoff Current ( $V_{CB} = 28$ V, $I_E = 0$ )                       | $I_{CBO}$     | —   | —   | 0.25 | mA <sub>dc</sub> |

**ON CHARACTERISTICS**

|                                                   |          |    |   |     |   |
|---------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 100$ mA, $V_{CE} = 5$ V) | $h_{FE}$ | 15 | — | 120 | — |
|---------------------------------------------------|----------|----|---|-----|---|

**DYNAMIC CHARACTERISTICS**

|                                                                |          |   |   |     |    |
|----------------------------------------------------------------|----------|---|---|-----|----|
| Output Capacitance ( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | — | 3.5 | pF |
|----------------------------------------------------------------|----------|---|---|-----|----|

**FUNCTIONAL TESTS**

|                                                                                                                                     |           |                                   |   |   |     |
|-------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------------------------|---|---|-----|
| Oscillator Output Power ( $V_{CE} = 20$ V, $f = 2.3$ GHz, $I_E = 120$ mA)                                                           | $P_{out}$ | 0.6                               | — | — | W   |
| Load Mismatch<br>( $V_{CE} = 20$ V, $I_E = 120$ mA, $P_{out} = 0.6$ W, $f = 2.3$ GHz,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$    | No Degradation in<br>Output Power |   |   |     |
| Cutoff Frequency ( $V_{CE} = 20$ V, $I_E = 120$ mA)                                                                                 | $f_r$     | —                                 | 3 | — | GHz |

## TYPICAL CHARACTERISTICS

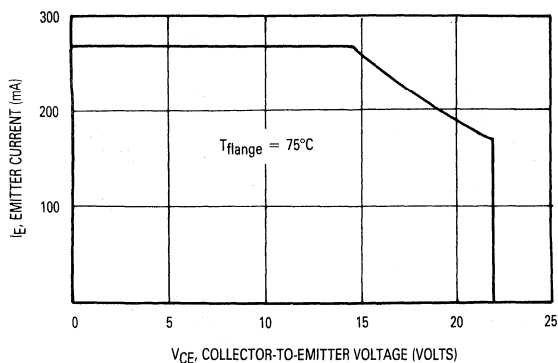


Figure 1. DC Safe Operating Area

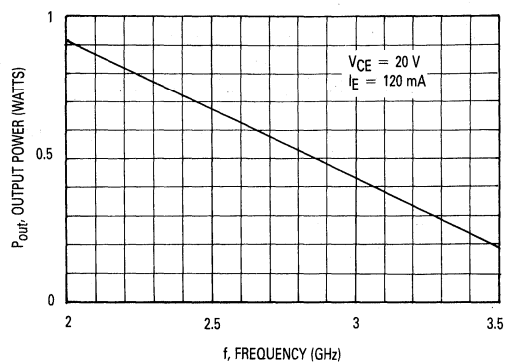
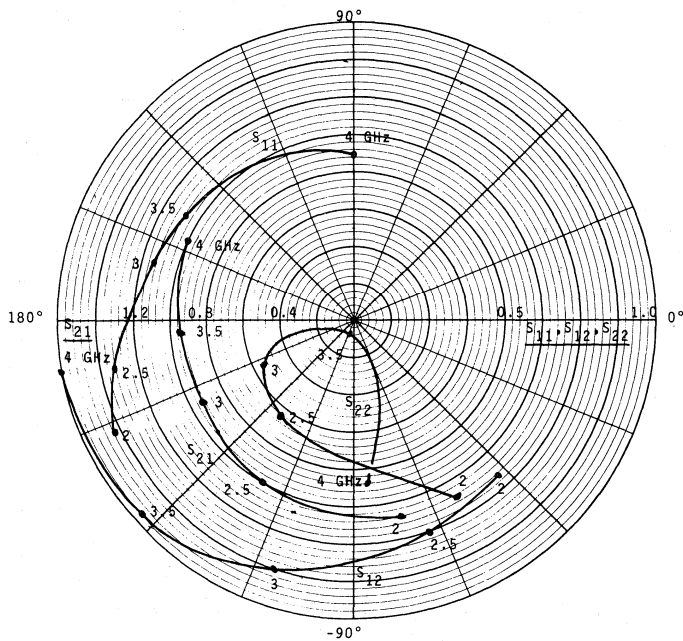


Figure 2. Output Power versus Frequency

Figure 3. Small Signal S-Parameters  
( $V_{CE} = 20\text{ V}$ ,  $I_E = 120\text{ mA}$ )

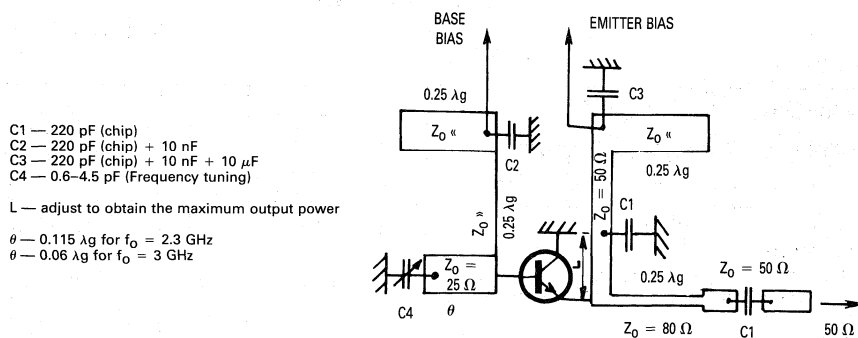
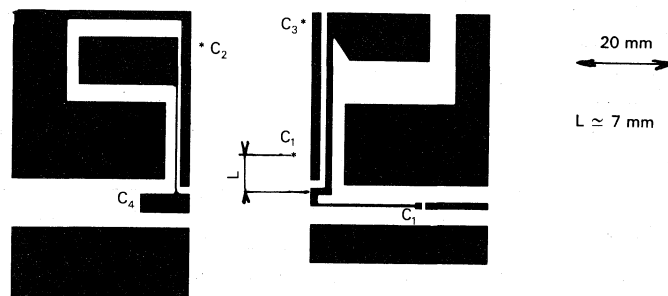
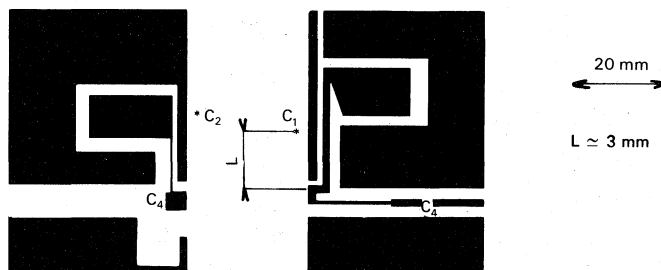


Figure 4. Test Circuit

Figure 5. PC Board Layout for  $f_0 = 2.3$  GHz (BW = 500 MHz)Figure 6. PC Board Layout for  $f_0 = 3$  GHz (BW = 500 MHz)

\*Foil-wrap asterisked edge to ground plane.  
 Board material: -0.020" Glass teflon ( $\epsilon_r = 2.55$ )  
 Adjust L to obtain the maximum output power

# The RF Line

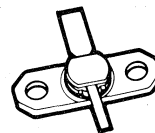
## Microwave Power Oscillator Transistor

... designed for use as power oscillators at frequencies to 3.5 GHz with guaranteed output power of 1.2 W @ 2.3 GHz.

- Operation to 3.5 GHz
- High Output Power (0.85 W Typ @ 3 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistor
- Common Collector Configuration

**TRW63602**

**MICROWAVE  
POWER  
OSCILLATOR  
TRANSISTOR**



**GP-13  
CASE 328F-01, STYLE 3**

### MAXIMUM RATINGS

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 20          | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 45          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 17  | °C/W |

### ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                               |               |     |   |     |      |
|-------------------------------------------------------------------------------|---------------|-----|---|-----|------|
| Collector-Emitter Breakdown Voltage ( $I_C = 20$ mA, $I_B = 0$ )              | $V_{(BR)CEO}$ | 20  | — | —   | Vdc  |
| Collector-Base Breakdown Voltage ( $I_C = 2$ mA, $I_E = 0$ )                  | $V_{(BR)CBO}$ | 45  | — | —   | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 0.5$ mA, $I_C = 0$ )                  | $V_{(BR)EBO}$ | 3.5 | — | —   | Vdc  |
| Collector-Emitter Breakdown Voltage ( $I_C = 20$ mA, $R_{BE} = 10$ $\Omega$ ) | $V_{(BR)CER}$ | 50  | — | —   | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 28$ V, $I_E = 0$ )                       | $I_{CBO}$     | —   | — | 0.5 | mAdc |

### ON CHARACTERISTICS

|                                                   |          |    |   |     |   |
|---------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 200$ mA, $V_{CE} = 5$ V) | $h_{FE}$ | 15 | — | 120 | — |
|---------------------------------------------------|----------|----|---|-----|---|

### DYNAMIC CHARACTERISTICS

|                                                                |          |   |   |     |    |
|----------------------------------------------------------------|----------|---|---|-----|----|
| Output Capacitance ( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | — | 5.5 | pF |
|----------------------------------------------------------------|----------|---|---|-----|----|

### FUNCTIONAL TESTS

|                                                                                                                                     |           |                                |   |   |     |
|-------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------------|---|---|-----|
| Oscillator Output Power ( $V_{CE} = 20$ V, $f = 2.3$ GHz, $I_E = 230$ mA)                                                           | $P_{out}$ | 1.2                            | — | — | W   |
| Load Mismatch<br>( $V_{CE} = 20$ V, $I_E = 230$ mA, $P_{out} = 1.2$ W, $f = 2.3$ GHz,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$    | No Degradation in Output Power |   |   |     |
| Cutoff Frequency ( $V_{CE} = 20$ V, $I_E = 230$ mA)                                                                                 | $f_T$     | —                              | 3 | — | GHz |

## TYPICAL CHARACTERISTICS

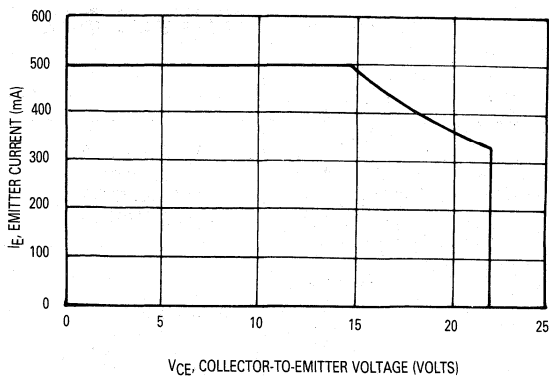


Figure 1. DC Safe Operating Area

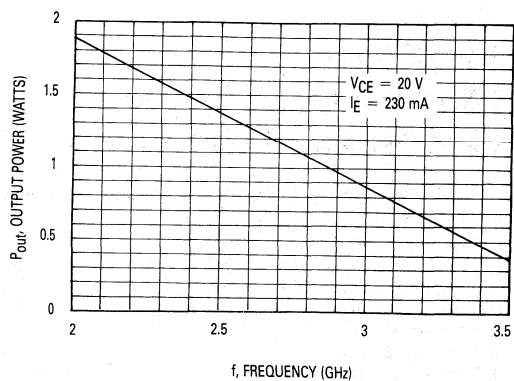
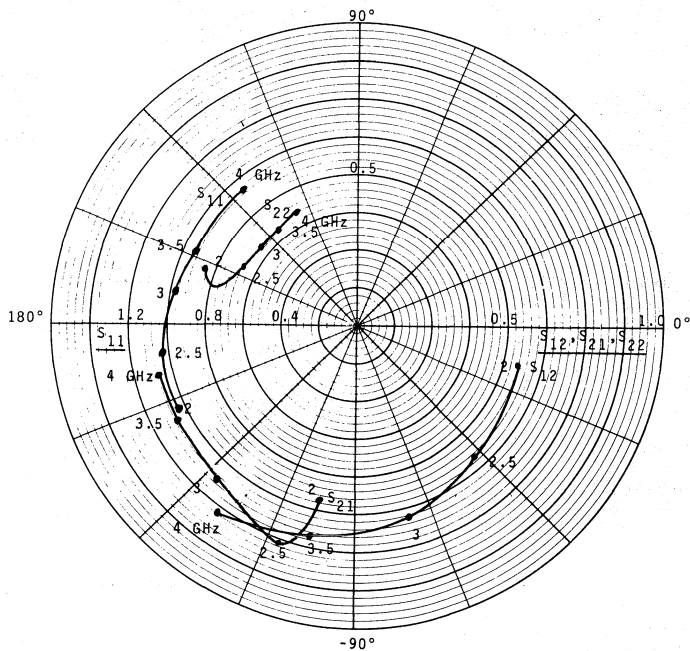


Figure 2. Output Power versus Frequency

Figure 3. Small Signal S-Parameters  
( $V_{CE} = 20$  V,  $I_E = 230$  mA)

C1 — 220 pF (chip)  
 C2 — 220 pF (chip) + 10 nF  
 C3 — 220 pF (chip) + 10 nF + 10  $\mu$ F  
 C4 — 0.6–4.5 pF (Frequency tuning)

L — adjust to obtain the maximum output power

$\theta$  — 0.115  $\lambda g$  for  $f_0 = 2.3$  GHz  
 $\theta$  — 0.06  $\lambda g$  for  $f_0 = 3$  GHz

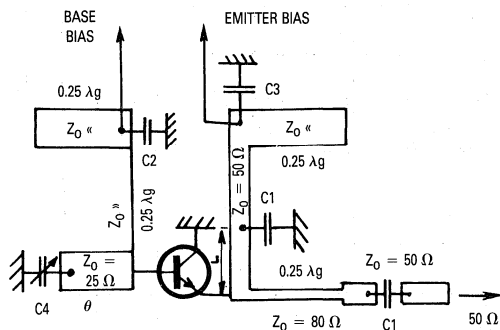


Figure 4. Test Circuit

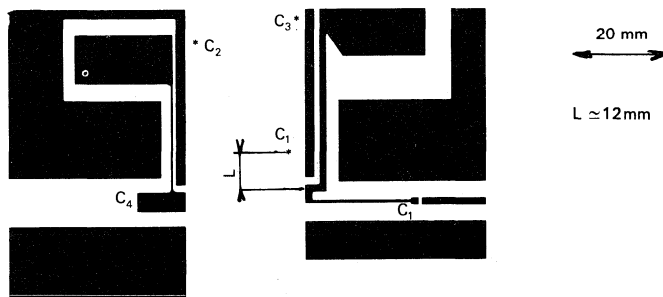


Figure 5. PC Board Layout for  $f_0 = 2.3$  GHz (BW = 500 MHz)

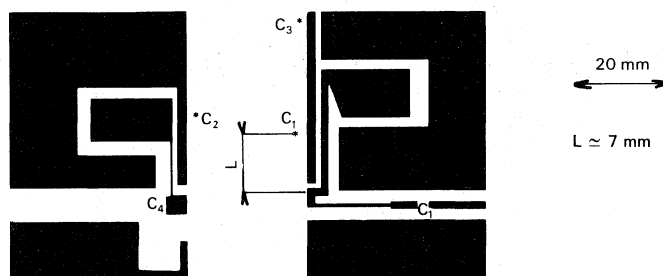


Figure 6. PC Board Layout for  $f_0 = 3$  GHz (BW = 500 MHz)

\*Foil-wrap asterisked edge to ground plane.  
 Board material: — 0.020" Glass teflon ( $\epsilon_r = 2.55$ )  
 Adjust L to obtain the maximum output power

**The RF Line**

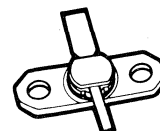
**Microwave Power  
Oscillator Transistor**

... designed for use as power oscillators at frequencies to 5 GHz with guaranteed output power 0.3 W @ 4 GHz.

- Operation to 5 GHz
- High Output Power (0.35 W Typ @ 4 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistor
- Common Collector Configuration

**TRW64601**

**MICROWAVE  
POWER  
OSCILLATOR  
TRANSISTOR**



GP-13  
CASE 328F-01, STYLE 3

**MAXIMUM RATINGS**

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CE}$  | 22          | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 45          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

**THERMAL CHARACTERISTICS**

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 40  | °C/W |

**ELECTRICAL CHARACTERISTICS**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**OFF CHARACTERISTICS**

|                                                                               |               |     |   |      |      |
|-------------------------------------------------------------------------------|---------------|-----|---|------|------|
| Collector-Emitter Breakdown Voltage ( $I_C = 10$ mA, $I_E = 0$ )              | $V_{(BR)CEO}$ | 22  | — | —    | Vdc  |
| Collector-Base Breakdown Voltage ( $I_C = 1$ mA, $I_E = 0$ )                  | $V_{(BR)CBO}$ | 45  | — | —    | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 0.25$ mA, $I_C = 0$ )                 | $V_{(BR)EBO}$ | 3.5 | — | —    | Vdc  |
| Collector-Emitter Breakdown Voltage ( $I_C = 10$ mA, $R_{BE} = 10$ $\Omega$ ) | $V_{(BR)CER}$ | 50  | — | —    | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 28$ V, $I_E = 0$ )                       | $I_{CBO}$     | —   | — | 0.25 | mAdc |

**ON CHARACTERISTICS**

|                                                   |          |    |   |     |   |
|---------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 100$ mA, $V_{CE} = 5$ V) | $h_{FE}$ | 20 | — | 120 | — |
|---------------------------------------------------|----------|----|---|-----|---|

**DYNAMIC CHARACTERISTICS**

|                                                                |          |   |   |     |    |
|----------------------------------------------------------------|----------|---|---|-----|----|
| Output Capacitance ( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | — | 3.5 | pF |
|----------------------------------------------------------------|----------|---|---|-----|----|

**FUNCTIONAL TESTS**

|                                                                                                                                   |           |                                   |      |   |     |
|-----------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------------------------|------|---|-----|
| Oscillator Output Power ( $V_{CE} = 20$ V, $f = 4$ GHz, $I_E = 120$ mA)                                                           | $P_{out}$ | 0.3                               | 0.35 | — | W   |
| Load Mismatch<br>( $V_{CE} = 20$ V, $I_E = 120$ mA, $P_{out} = 0.3$ W, $f = 4$ GHz,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$    | No Degradation in<br>Output Power |      |   |     |
| Cutoff Frequency ( $V_{CE} = 20$ V, $I_E = 120$ mA)                                                                               | $f_T$     | —                                 | 4    | — | GHz |



## TYPICAL CHARACTERISTICS

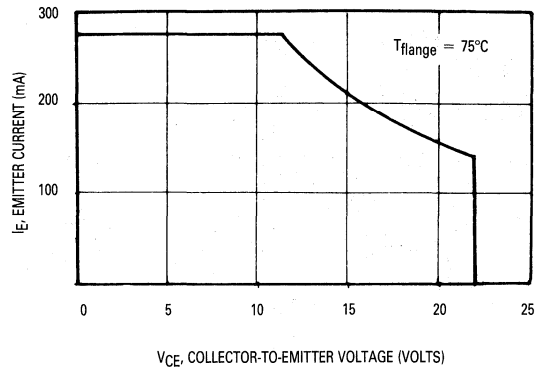


Figure 1. DC Safe Operating Area

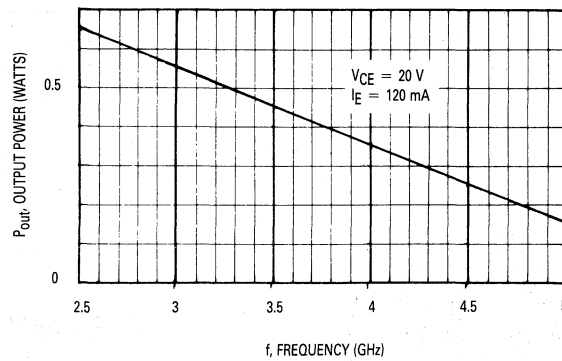


Figure 2. Output Power versus Frequency

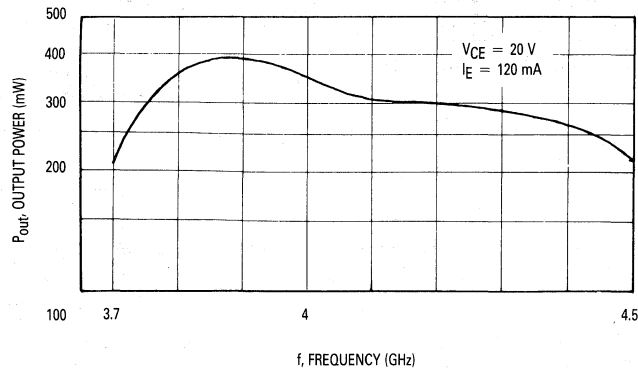
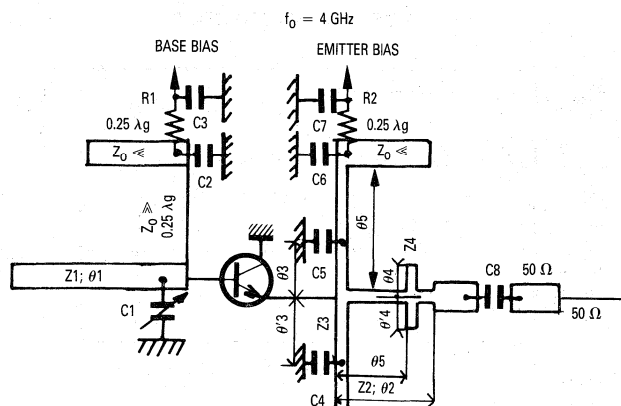
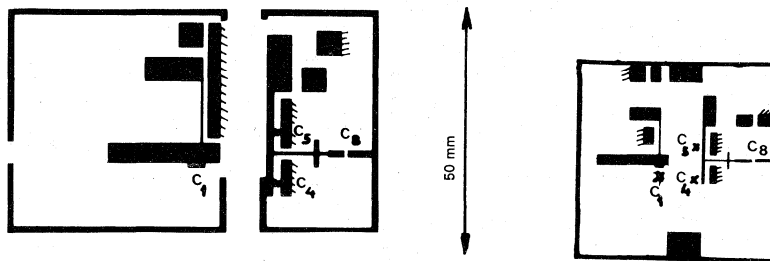


Figure 3. Output Power versus Frequency with a Fixed Tuned Output Circuit



$Z1 - 23.5 \Omega$      $\theta1 - 0.52 \lambda_g$   
 $Z2 - 80/67 \Omega$      $\theta2 - 0.25 \lambda_g$   
 $Z3 - 50 \Omega$      $\theta3 - 0.095 \lambda_g$ ;  $\theta'3 - 0.140 \lambda_g$   
 $Z4 - 62 \Omega$     Adjust  $\theta3$  and  $\theta'3$  to obtain the maximum output power  
 $\theta5 - 0.18 \lambda_g$      $\theta4 - 0.05 \lambda_g$   
 $R1 - 160 \Omega$   
 $R2 - 1 \Omega$   
 $C1 - 0.4-2.5 \text{ pF}$   
 $C2, C6 - 100 \text{ pF (chip)} + 10 \text{ nF}$   
 $C3, C7 - 10 \text{ nF}$   
 $C4, C5, C8 - 33 \text{ pF (chip)}$

Figure 4. Test Circuit



//// Foil wrap edge to ground plane

Board Material: 0.020" Glass teflon;  
 $\epsilon_r = 2.55$   
 Board Material: 0.025"  
 Epsilon 10;  $\epsilon_r = 10.2$

Figure 5. PC Board Layout for  $f_0 = 4 \text{ GHz}$  (BW = 700 MHz)

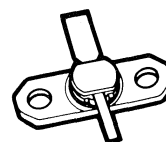
# The RF Line Microwave Power Oscillator Transistor

**TRW64602**

**MICROWAVE  
POWER  
OSCILLATOR  
TRANSISTOR**

... designed for use as power oscillators at frequencies to 5 GHz with guaranteed output power of 0.55 W @ 4 GHz.

- Operation to 5 GHz
- High Output Power (65 W Typ @ 4 GHz)
- Rugged— Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistor



**GP-13  
CASE 328F-01, STYLE 3**

#### MAXIMUM RATINGS

| Rating                         | Symbol    | Value       | Unit |
|--------------------------------|-----------|-------------|------|
| Collector-Emitter Voltage      | $V_{CEO}$ | 22          | Vdc  |
| Collector-Base Voltage         | $V_{CBO}$ | 45          | Vdc  |
| Emitter-Base Voltage           | $V_{EBO}$ | 3.5         | Vdc  |
| Operating Junction Temperature | $T_J$     | 200         | °C   |
| Storage Temperature Range      | $T_{stg}$ | -65 to +200 | °C   |

#### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max | Unit |
|--------------------------------------|-----------------|-----|------|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 20  | °C/W |

#### ELECTRICAL CHARACTERISTICS

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

#### OFF CHARACTERISTICS

|                                                                             |               |     |   |     |      |
|-----------------------------------------------------------------------------|---------------|-----|---|-----|------|
| Collector-Emitter Breakdown Voltage ( $I_C = 20$ mA, $I_B = 0$ )            | $V_{(BR)CEO}$ | 22  | — | —   | Vdc  |
| Collector-Base Breakdown Voltage ( $I_C = 2$ mA, $I_E = 0$ )                | $V_{(BR)CBO}$ | 45  | — | —   | Vdc  |
| Emitter-Base Breakdown Voltage ( $I_E = 0.5$ mA, $I_C = 0$ )                | $V_{(BR)EBO}$ | 3.5 | — | —   | Vdc  |
| Collector-Emitter Breakdown Voltage ( $I_C = 20$ mA, $R_{BE} = 10 \Omega$ ) | $V_{(BR)CER}$ | 50  | — | —   | Vdc  |
| Collector Cutoff Current ( $V_{CB} = 28$ V, $I_E = 0$ )                     | $I_{CBO}$     | —   | — | 0.5 | mAdc |

#### ON CHARACTERISTICS

|                                                   |          |    |   |     |   |
|---------------------------------------------------|----------|----|---|-----|---|
| DC Current Gain ( $I_C = 200$ mA, $V_{CE} = 5$ V) | $h_{FE}$ | 20 | — | 120 | — |
|---------------------------------------------------|----------|----|---|-----|---|

#### DYNAMIC CHARACTERISTICS

|                                                                |          |   |   |     |    |
|----------------------------------------------------------------|----------|---|---|-----|----|
| Output Capacitance ( $V_{CB} = 28$ V, $I_E = 0$ , $f = 1$ MHz) | $C_{ob}$ | — | — | 5.5 | pF |
|----------------------------------------------------------------|----------|---|---|-----|----|

#### FUNCTIONAL TESTS

|                                                                                                                                    |          |                                |     |   |    |
|------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------|-----|---|----|
| Oscillator Output Power ( $V_{CE} = 20$ V, $f = 4$ GHz, $I_C = 240$ mA)                                                            | $G_{PE}$ | 550                            | 650 | — | mW |
| Load Mismatch<br>( $V_{CE} = 20$ V, $I_C = 240$ mA, $P_{out} = 550$ mW, $f = 4$ GHz,<br>Load VSWR = $\infty:1$ , All Phase Angles) | $\psi$   | No Degradation in Output Power |     |   |    |

## TYPICAL CHARACTERISTICS

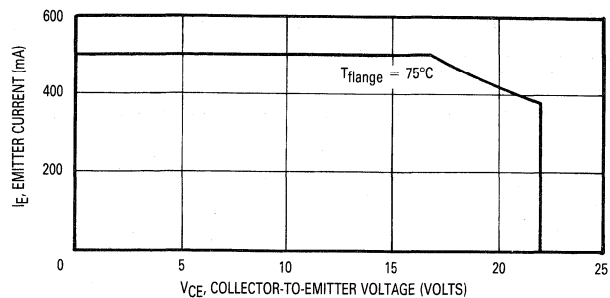


Figure 1. DC Safe Operating Area

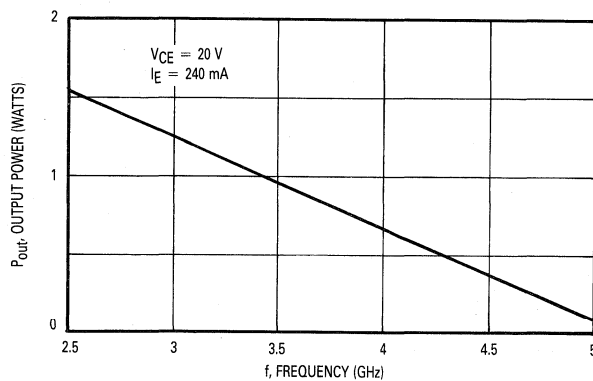
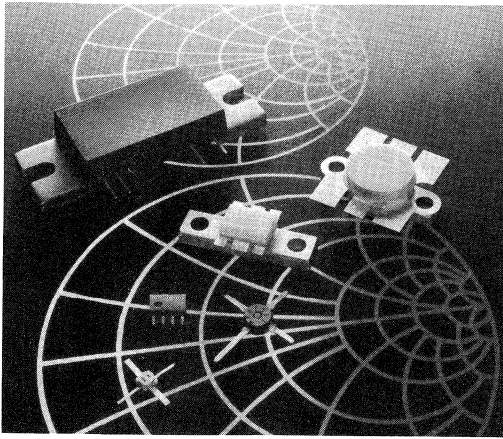


Figure 2. Output Power versus Frequency



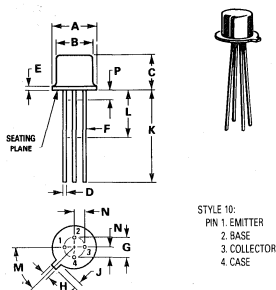


## Volume I

## Case Dimensions 3

# Case Dimensions

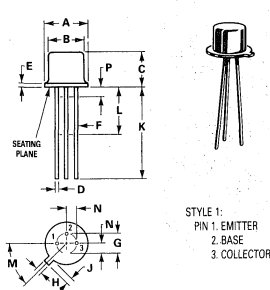
3



STYLE 10:  
PIN 1. EMITTER  
2. BASE  
3. COLLECTOR  
4. CASE

| DIM | MILLIMETERS |         | INCHES    |       |
|-----|-------------|---------|-----------|-------|
|     | MIN         | MAX     | MIN       | MAX   |
| A   | 5.31        | 5.84    | 0.209     | 0.230 |
| B   | 4.52        | 4.95    | 0.178     | 0.195 |
| C   | 4.32        | 5.33    | 0.170     | 0.210 |
| D   | 0.41        | 0.53    | 0.016     | 0.021 |
| E   | 0.76        | —       | 0.030     | —     |
| F   | 0.41        | 0.48    | 0.016     | 0.019 |
| G   | 2.54 BSC    | —       | 0.100 BSC | —     |
| H   | 0.91        | 1.17    | 0.036     | 0.046 |
| J   | 0.71        | 1.22    | 0.028     | 0.048 |
| K   | 12.70       | —       | 0.500     | —     |
| L   | 6.35        | —       | 0.250     | —     |
| M   | 45° BSC     | 45° BSC | —         | —     |
| N   | 1.27 BSC    | —       | 0.050 BSC | —     |
| P   | —           | 1.27    | —         | 0.050 |

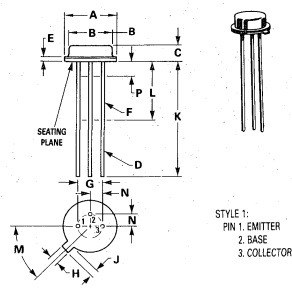
CASE 20-03  
(TO-206AF)



STYLE 1:  
PIN 1. EMITTER  
2. BASE  
3. COLLECTOR

| DIM | MILLIMETERS |         | INCHES    |       |
|-----|-------------|---------|-----------|-------|
|     | MIN         | MAX     | MIN       | MAX   |
| A   | 5.31        | 5.84    | 0.209     | 0.230 |
| B   | 4.52        | 4.95    | 0.178     | 0.195 |
| C   | 4.32        | 5.33    | 0.170     | 0.210 |
| D   | 0.406       | 0.533   | 0.016     | 0.021 |
| E   | —           | 0.762   | —         | 0.030 |
| F   | 0.406       | 0.483   | 0.016     | 0.019 |
| G   | 2.54 BSC    | —       | 0.100 BSC | —     |
| H   | 0.914       | 1.17    | 0.036     | 0.046 |
| J   | 0.711       | 1.22    | 0.028     | 0.048 |
| K   | 12.70       | —       | 0.500     | —     |
| L   | 6.35        | —       | 0.250     | —     |
| M   | 45° BSC     | 45° BSC | —         | —     |
| N   | 1.27 BSC    | —       | 0.050 BSC | —     |
| P   | —           | 1.27    | —         | 0.050 |

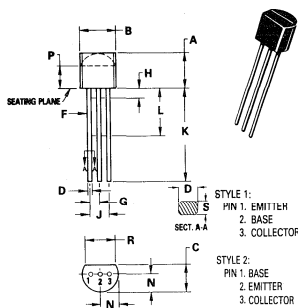
CASE 22-03  
(TO-206AA)



STYLE 1:  
PIN 1. EMITTER  
2. BASE  
3. COLLECTOR

| DIM | MILLIMETERS |         | INCHES    |       |
|-----|-------------|---------|-----------|-------|
|     | MIN         | MAX     | MIN       | MAX   |
| A   | 5.31        | 5.84    | 0.209     | 0.230 |
| B   | 4.52        | 4.95    | 0.178     | 0.195 |
| C   | 1.65        | 2.16    | 0.065     | 0.085 |
| D   | 0.406       | 0.533   | 0.016     | 0.021 |
| E   | —           | 1.02    | —         | 0.040 |
| F   | 0.305       | 0.483   | 0.012     | 0.019 |
| G   | 2.54 BSC    | —       | 0.100 BSC | —     |
| H   | 0.914       | 1.17    | 0.036     | 0.046 |
| J   | 0.711       | 1.22    | 0.028     | 0.048 |
| K   | 12.70       | —       | 0.500     | —     |
| L   | 6.35        | —       | 0.250     | —     |
| M   | 45° BSC     | 45° BSC | —         | —     |
| N   | 1.27 BSC    | —       | 0.050 BSC | —     |
| P   | —           | 1.27    | —         | 0.050 |

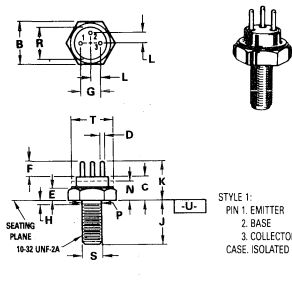
CASE 26-03  
(TO-206AB)



STYLE 1:  
PIN 1. EMITTER  
2. BASE  
3. COLLECTOR  
STYLE 2:  
PIN 1. BASE  
2. EMITTER  
3. COLLECTOR

| DIM | MILLIMETERS |      | INCHES |       |
|-----|-------------|------|--------|-------|
|     | MIN         | MAX  | MIN    | MAX   |
| A   | 4.32        | 5.33 | 0.170  | 0.210 |
| B   | 4.45        | 5.20 | 0.175  | 0.205 |
| C   | 3.18        | 4.19 | 0.125  | 0.165 |
| D   | 0.41        | 0.55 | 0.016  | 0.022 |
| F   | 0.41        | 0.48 | 0.016  | 0.019 |
| G   | 1.15        | 1.39 | 0.045  | 0.055 |
| H   | —           | 2.54 | —      | 0.100 |
| J   | 2.42        | 2.86 | 0.095  | 0.105 |
| K   | 12.70       | —    | 0.500  | —     |
| L   | 6.35        | —    | 0.250  | —     |
| N   | 2.04        | 2.86 | 0.080  | 0.105 |
| P   | 2.93        | —    | 0.115  | —     |
| R   | 3.43        | —    | 0.135  | —     |
| S   | 0.39        | 0.50 | 0.015  | 0.020 |

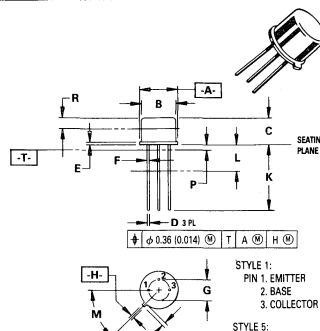
CASE 29-04  
(TO-226AA)



STYLE 1:  
PIN 1. EMITTER  
2. BASE  
3. COLLECTOR  
CASE ISOLATED

| DIM | MILLIMETERS |       | INCHES    |        |
|-----|-------------|-------|-----------|--------|
|     | MIN         | MAX   | MIN       | MAX    |
| A   | 10.77       | 11.10 | 0.424     | 0.437  |
| B   | 6.22        | 7.49  | 0.245     | 0.295  |
| C   | 0.88        | 1.52  | 0.035     | 0.060  |
| D   | 2.54        | 3.42  | 0.100     | 0.135  |
| E   | 3.55        | 4.06  | 0.140     | 0.160  |
| F   | 5.08 BSC    | —     | 0.200 BSC | —      |
| G   | —           | 1.98  | —         | 0.078  |
| H   | 10.41       | 11.56 | 0.410     | 0.455  |
| J   | 9.65        | 12.19 | 0.380     | 0.480  |
| K   | 2.54 BSC    | —     | 0.100 BSC | —      |
| L   | —           | 4.19  | —         | 0.165  |
| M   | 4.14        | 4.80  | 0.163     | 0.189  |
| N   | 8.13        | 9.14  | 0.320     | 0.360  |
| P   | 4.650       | 4.803 | 0.1831    | 0.1891 |
| T   | 9.14        | 11.10 | 0.360     | 0.437  |

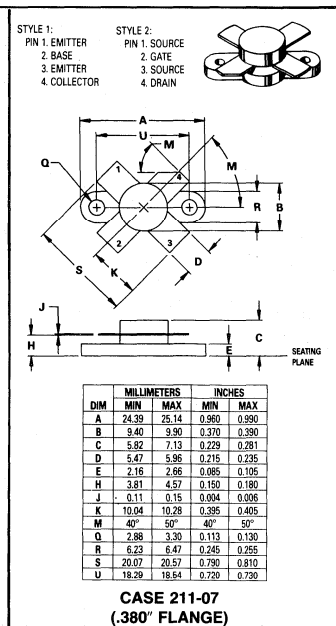
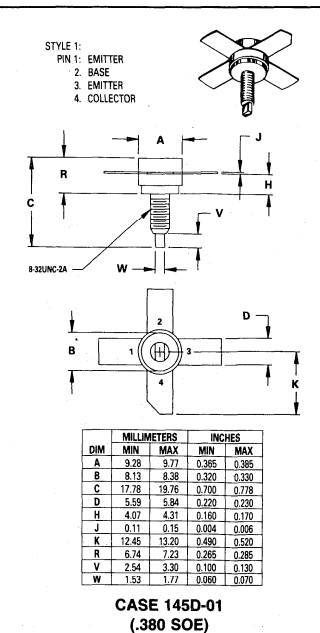
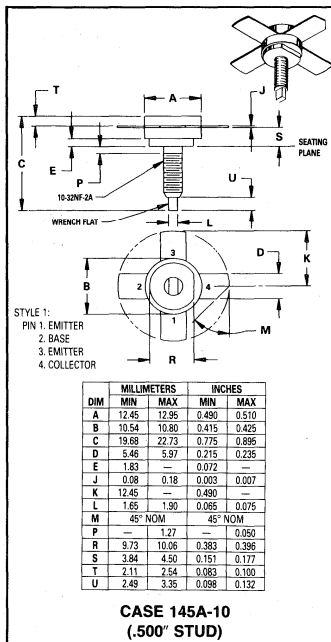
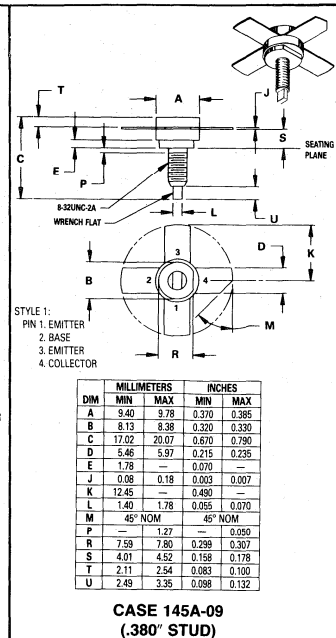
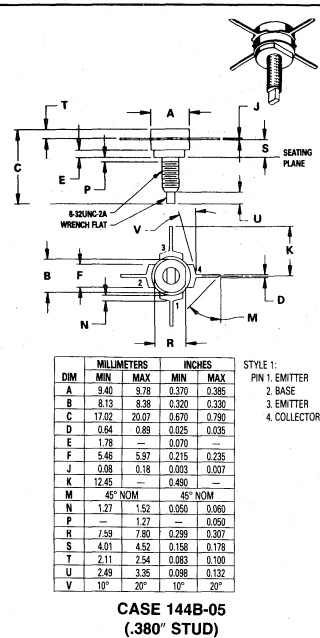
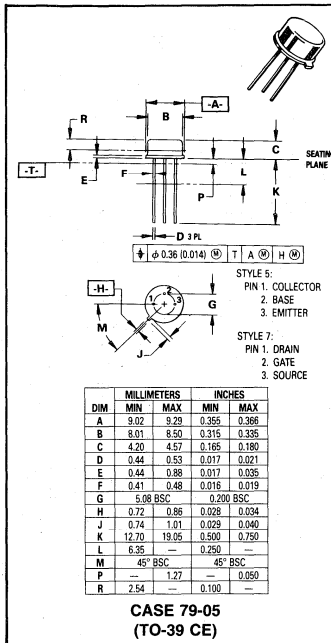
CASE 36-03  
(TO-60)



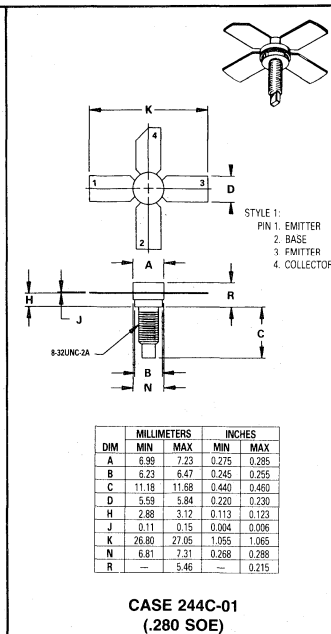
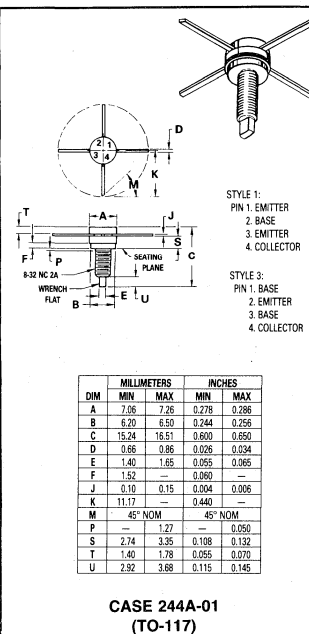
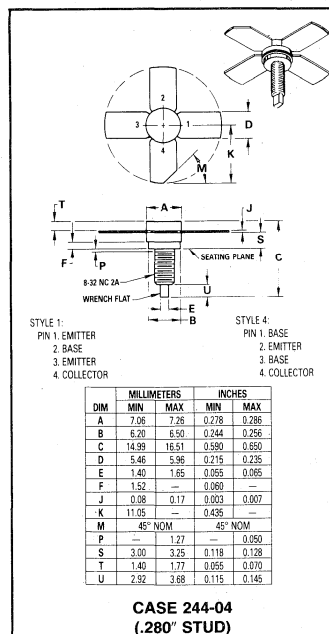
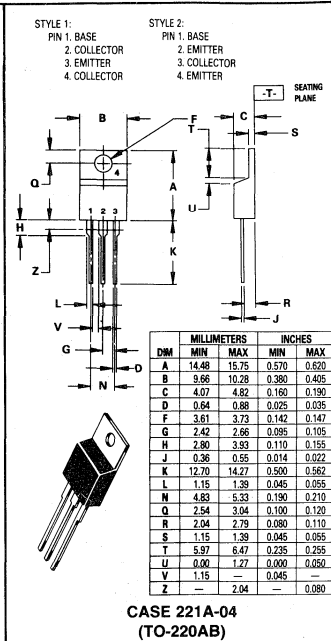
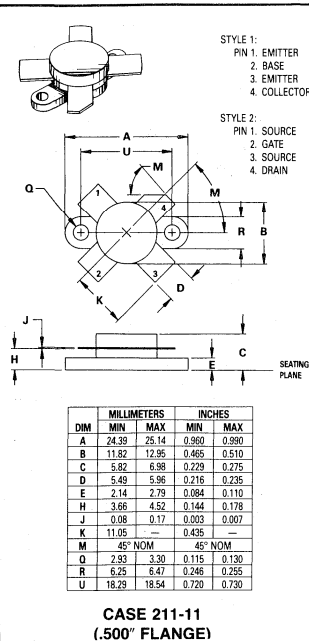
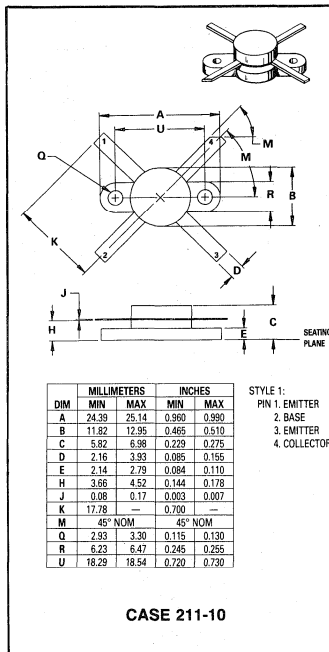
STYLE 1:  
PIN 1. EMITTER  
2. BASE  
3. COLLECTOR  
STYLE 5:  
PIN 1. COLLECTOR  
2. BASE  
3. EMITTER

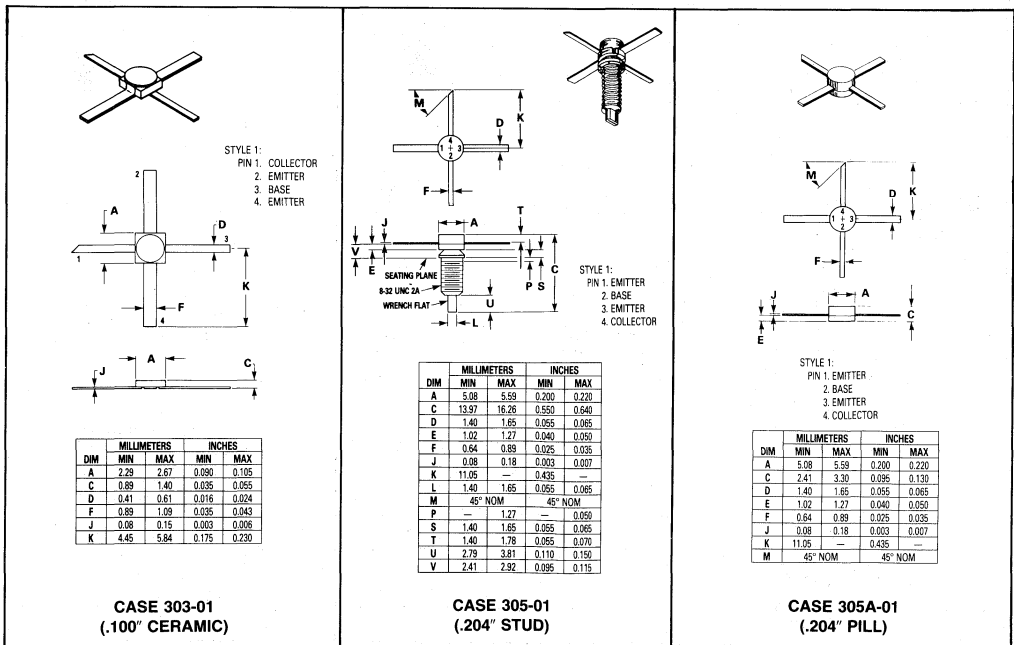
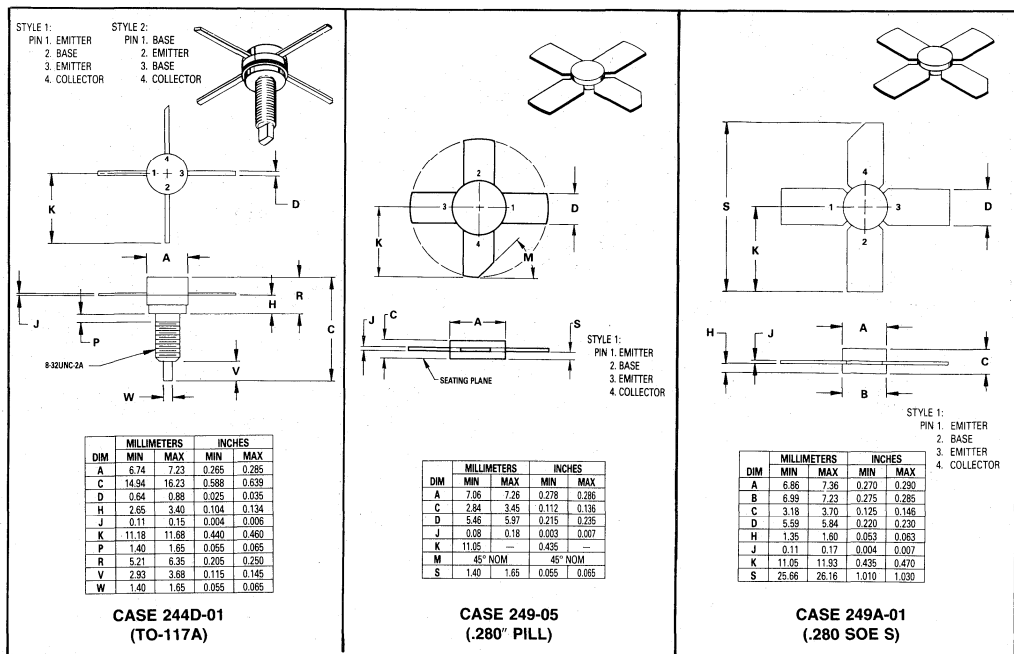
| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 8.51        | 9.39  | 0.335     | 0.370 |
| B   | 7.75        | 8.50  | 0.305     | 0.335 |
| C   | 6.10        | 6.60  | 0.240     | 0.260 |
| D   | 0.41        | 0.53  | 0.016     | 0.021 |
| E   | 0.23        | 1.04  | 0.009     | 0.041 |
| F   | 0.41        | 0.48  | 0.016     | 0.019 |
| G   | 5.08 BSC    | —     | 0.200 BSC | —     |
| H   | 0.72        | 0.86  | 0.028     | 0.034 |
| J   | 0.74        | 1.14  | 0.029     | 0.045 |
| K   | 12.70       | 19.05 | 0.500     | 0.750 |
| L   | 6.35        | —     | 0.250     | —     |
| M   | 45° BSC     | —     | 45° BSC   | —     |
| P   | —           | 1.27  | —         | 0.050 |
| R   | 2.54        | —     | 0.100     | —     |

CASE 79-04  
(TO-205AD)



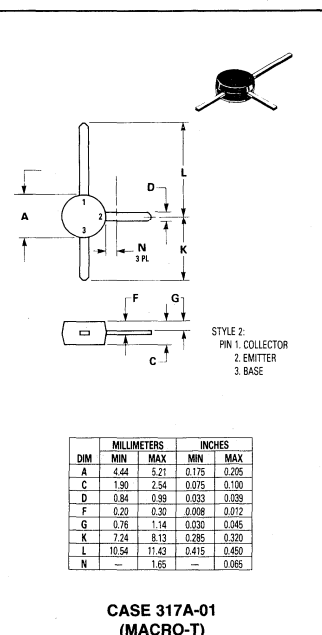
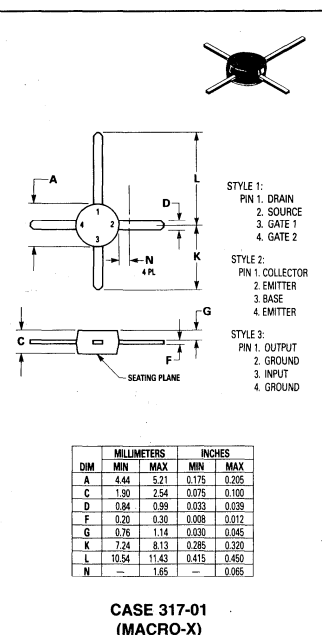
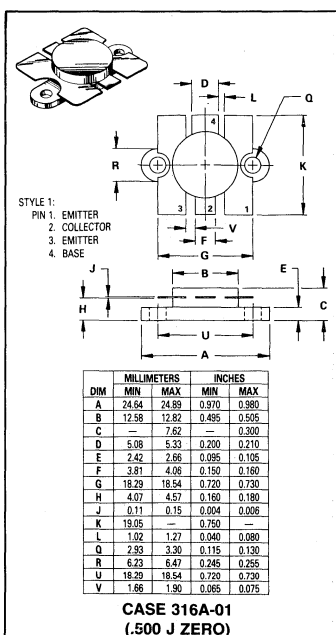
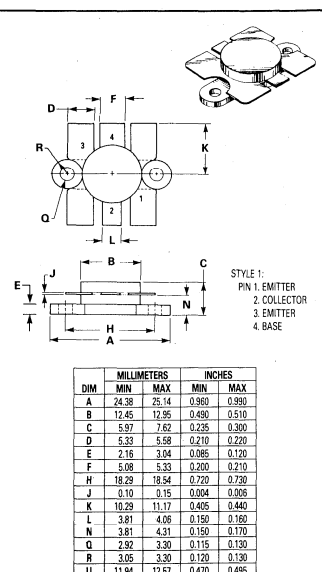
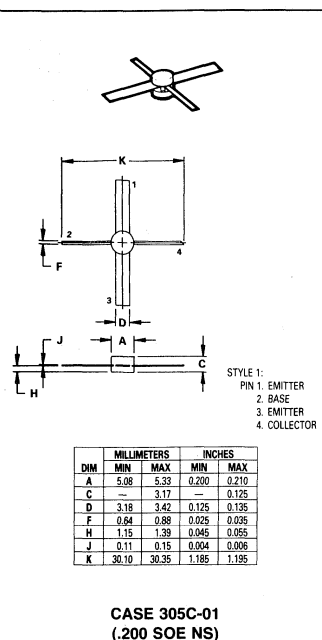
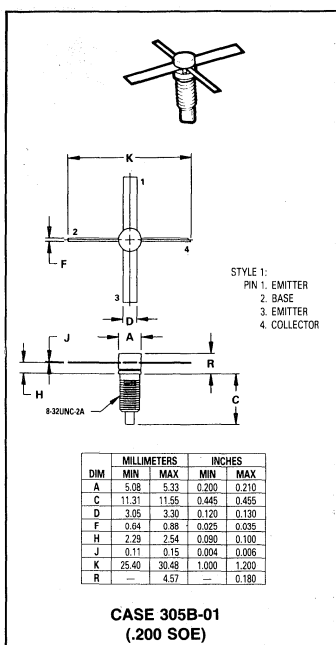


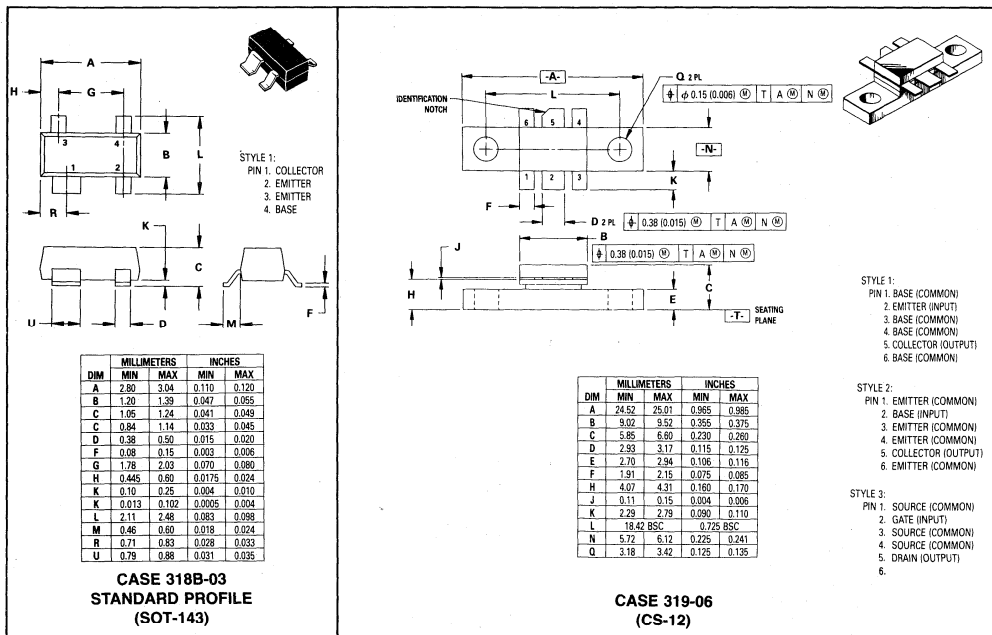
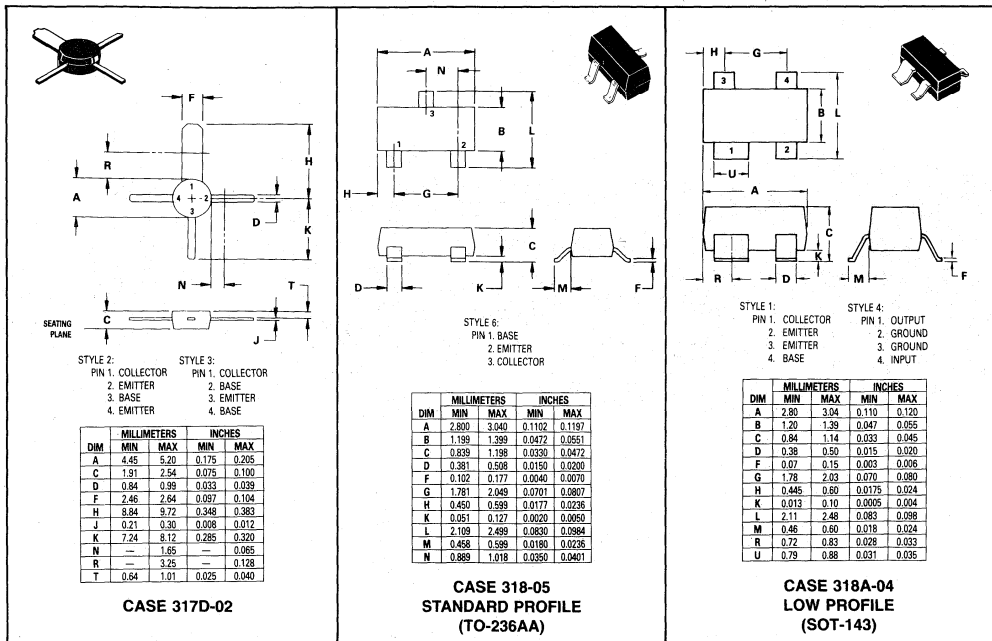




# CASE DIMENSIONS (continued)

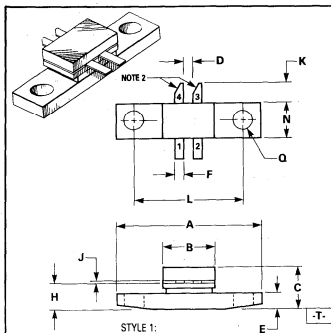
3





# CASE DIMENSIONS (continued)

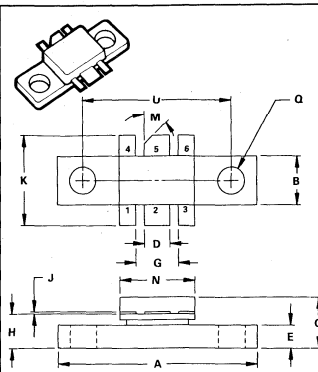
3



STYLE 1:  
PIN 1. GATE (INPUT)  
2. GATE (INPUT)  
3. DRAIN (OUTPUT)  
4. DRAIN (OUTPUT)  
SOURCE IS FLANGE

| DIM | MIN       | MAX   | MIN       | MAX   |
|-----|-----------|-------|-----------|-------|
| A   | 24.51     | 25.02 | 0.965     | 0.985 |
| B   | 9.02      | 9.52  | 0.355     | 0.375 |
| C   | 5.84      | 6.60  | 0.230     | 0.260 |
| D   | 1.40      | 1.65  | 0.055     | 0.065 |
| E   | 2.69      | 2.94  | 0.106     | 0.116 |
| F   | 1.4       | 1.65  | 0.055     | 0.065 |
| H   | 4.05      | 4.31  | 0.160     | 0.170 |
| J   | 0.10      | 0.15  | 0.004     | 0.006 |
| K   | 3.05      | 3.55  | 0.120     | 0.140 |
| L   | 18.42 BSC |       | 0.725 BSC |       |
| N   | 5.72      | 6.12  | 0.225     | 0.241 |
| Q   | 3.18      | 3.42  | 0.125     | 0.135 |

CASE 319B-01

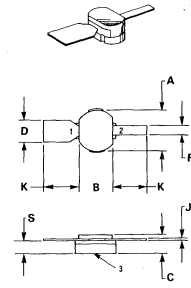


| DIM | MIN     | MAX   | MIN     | MAX   |
|-----|---------|-------|---------|-------|
| A   | 24.64   | 24.89 | 0.970   | 0.980 |
| B   | 5.72    | 5.96  | 0.225   | 0.235 |
| C   | 6.10    | 6.60  | 0.240   | 0.260 |
| D   | 2.93    | 3.17  | 0.115   | 0.125 |
| E   | 2.72    | 2.97  | 0.107   | 0.117 |
| G   | 4.83    | 5.33  | 0.190   | 0.210 |
| H   | 4.07    | 4.57  | 0.160   | 0.180 |
| J   | 0.11    | 0.15  | 0.004   | 0.006 |
| K   | 10.80   | 11.43 | 0.425   | 0.450 |
| M   | 45° NOM |       | 45° NOM |       |
| N   | 9.02    | 9.77  | 0.355   | 0.385 |
| Q   | 3.05    | 3.30  | 0.120   | 0.130 |
| U   | 18.29   | 18.54 | 0.720   | 0.730 |

STYLE 1:  
PIN 1. BASE  
2. EMITTER  
3. BASE  
4. BASE  
5. COLLECTOR  
6. BASE

STYLE 2:  
PIN 1. EMITTER  
2. BASE  
3. EMITTER  
4. EMITTER  
5. COLLECTOR  
6. EMITTER

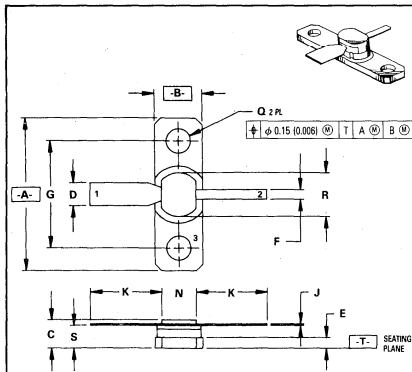
CASE 319C-01  
(EB)



STYLE 1:  
PIN 1. EMITTER  
2. COLLECTOR  
3. BASE

| DIM | MIN  | MAX  | MIN   | MAX   |
|-----|------|------|-------|-------|
| A   | 5.72 | 5.97 | 0.225 | 0.235 |
| B   | 4.44 | 4.70 | 0.175 | 0.185 |
| C   | 2.29 | 2.74 | 0.090 | 0.108 |
| D   | 2.92 | 3.18 | 0.115 | 0.125 |
| F   | 1.14 | 1.40 | 0.045 | 0.055 |
| J   | 0.08 | 0.15 | 0.003 | 0.006 |
| K   | —    | 9.52 | —     | 0.375 |
| S   | 1.52 | 1.78 | 0.060 | 0.070 |

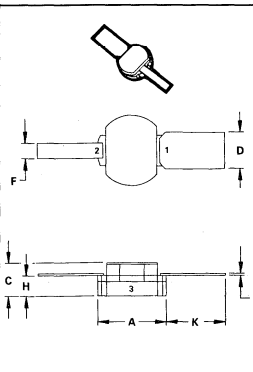
CASE 328-02



| DIM | MIN       | MAX   | MIN       | MAX   |
|-----|-----------|-------|-----------|-------|
| A   | 20.20     | 20.57 | 0.795     | 0.810 |
| B   | 6.23      | 6.47  | 0.245     | 0.255 |
| C   | 3.69      | 4.31  | 0.145     | 0.170 |
| D   | 2.93      | 3.17  | 0.115     | 0.125 |
| E   | 1.40      | 1.77  | 0.055     | 0.070 |
| F   | 1.15      | 1.39  | 0.045     | 0.055 |
| G   | 14.22 BSC |       | 0.562 BSC |       |
| J   | 0.08      | 0.15  | 0.003     | 0.006 |
| K   | —         | 9.52  | —         | 0.375 |
| N   | 4.45      | 4.69  | 0.175     | 0.185 |
| Q   | 2.95      | 3.42  | 0.120     | 0.135 |
| R   | 5.72      | 5.97  | 0.225     | 0.235 |
| S   | 2.92      | 3.55  | 0.115     | 0.140 |

CASE 328A-02  
(FLANGE)

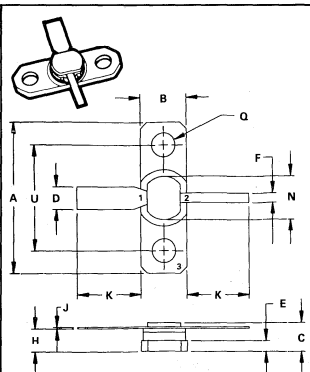
STYLE 1:  
PIN 1. EMITTER  
2. COLLECTOR  
3. BASE



| DIM | MIN  | MAX  | MIN   | MAX   |
|-----|------|------|-------|-------|
| A   | 5.72 | 5.96 | 0.225 | 0.235 |
| C   | 2.29 | 2.79 | 0.090 | 0.110 |
| D   | 2.93 | 3.17 | 0.115 | 0.125 |
| F   | 1.15 | 1.39 | 0.045 | 0.055 |
| H   | 1.66 | 1.90 | 0.065 | 0.075 |
| J   | 0.08 | 0.15 | 0.003 | 0.006 |
| K   | 5.72 | 6.99 | 0.225 | 0.275 |

CASE 328E-01  
(GP-13 FLANGLESS)

STYLE 1:  
PIN 1. EMITTER  
2. COLLECTOR  
3. BASE



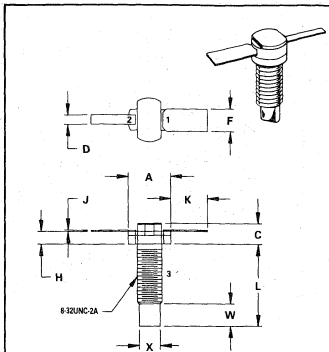
| DIM | MIN   | MAX   | MIN   | MAX   |
|-----|-------|-------|-------|-------|
| A   | 20.07 | 20.57 | 0.790 | 0.810 |
| B   | 6.10  | 6.60  | 0.240 | 0.260 |
| C   | 3.66  | 4.31  | 0.144 | 0.170 |
| D   | 2.93  | 3.17  | 0.115 | 0.125 |
| E   | 1.40  | 1.65  | 0.055 | 0.065 |
| F   | 1.15  | 1.39  | 0.045 | 0.055 |
| H   | 2.93  | 3.42  | 0.115 | 0.135 |
| J   | 0.08  | 0.15  | 0.003 | 0.006 |
| N   | 5.72  | 6.98  | 0.225 | 0.275 |
| N   | 5.59  | 6.09  | 0.220 | 0.240 |
| Q   | 3.18  | 3.42  | 0.125 | 0.135 |
| U   | 14.03 | 14.52 | 0.552 | 0.572 |

CASE 328F-01  
(GP-13)

STYLE 1:  
PIN 1. BASE  
2. COLLECTOR  
3. EMITTER

STYLE 2:  
PIN 1. EMITTER  
2. COLLECTOR  
3. BASE

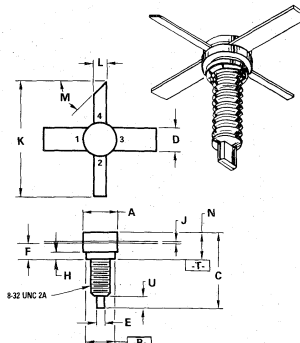
STYLE 3:  
PIN 1. BASE  
2. EMITTER  
3. COLLECTOR



STYLE 1:  
PIN 1. BASE  
2. COLLECTOR  
3. EMITTER

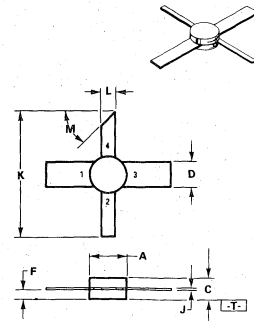
| DIM | MILLIMETERS |       |       | INCHES |     |  |
|-----|-------------|-------|-------|--------|-----|--|
|     | MIN         | MAX   |       | MIN    | MAX |  |
| A   | 5.72        | 6.09  | 0.225 | 0.240  |     |  |
| B   | —           | 2.79  | —     | 0.110  |     |  |
| C   | 1.15        | 1.39  | 0.045 | 0.055  |     |  |
| D   | 2.93        | 3.17  | 0.115 | 0.125  |     |  |
| E   | 1.53        | 1.90  | 0.060 | 0.075  |     |  |
| F   | 0.08        | 0.17  | 0.003 | 0.007  |     |  |
| G   | 5.08        | —     | 0.200 | —      |     |  |
| H   | 10.67       | 11.68 | 0.420 | 0.460  |     |  |
| J   | 2.80        | 3.30  | 0.110 | 0.130  |     |  |
| K   | 2.80        | 3.04  | 0.110 | 0.120  |     |  |

CASE 328G-01  
(GP-13 S)



| DIM | MILLIMETERS |       |       | INCHES |     |  |
|-----|-------------|-------|-------|--------|-----|--|
|     | MIN         | MAX   |       | MIN    | MAX |  |
| A   | 6.86        | 7.62  | 0.270 | 0.300  |     |  |
| B   | 6.10        | 6.60  | 0.240 | 0.250  |     |  |
| C   | 16.26       | 16.76 | 0.640 | 0.660  |     |  |
| D   | 4.95        | 5.21  | 0.195 | 0.205  |     |  |
| E   | 1.40        | 1.65  | 0.055 | 0.065  |     |  |
| F   | 2.67        | 4.32  | 0.105 | 0.170  |     |  |
| G   | 1.40        | 1.65  | 0.055 | 0.065  |     |  |
| H   | 0.08        | 0.18  | 0.003 | 0.007  |     |  |
| J   | 15.24       | —     | 0.600 | —      |     |  |
| K   | 2.41        | 2.67  | 0.095 | 0.105  |     |  |
| L   | 45°         | Norm  | 45°   | Norm   |     |  |
| M   | 4.57        | 6.22  | 0.180 | 0.245  |     |  |
| N   | 2.92        | 3.68  | 0.115 | 0.145  |     |  |

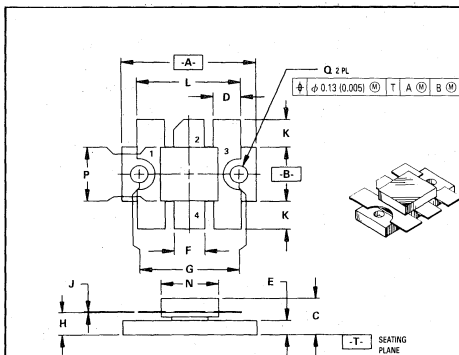
CASE 332-04  
(.380" STUD)



STYLE 2:  
PIN 1. EMITTER  
2. BASE  
3. EMITTER  
4. COLLECTOR

| DIM | MILLIMETERS |      |       | INCHES |     |  |
|-----|-------------|------|-------|--------|-----|--|
|     | MIN         | MAX  |       | MIN    | MAX |  |
| A   | 6.86        | 7.34 | 0.270 | 0.290  |     |  |
| B   | 3.30        | 3.81 | 0.130 | 0.150  |     |  |
| C   | 4.95        | 5.21 | 0.195 | 0.205  |     |  |
| D   | 1.40        | 1.78 | 0.055 | 0.070  |     |  |
| E   | 0.08        | 0.18 | 0.003 | 0.007  |     |  |
| F   | 15.24       | —    | 0.600 | —      |     |  |
| G   | 2.41        | 2.67 | 0.095 | 0.105  |     |  |
| H   | 45°         | NOM  | 45°   | NOM    |     |  |

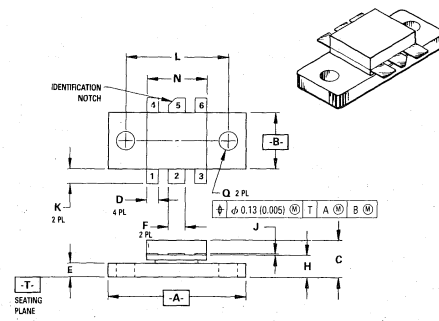
CASE 332A-01  
(.280" PILL)



| DIM | MILLIMETERS |       |       | INCHES |     |  |
|-----|-------------|-------|-------|--------|-----|--|
|     | MIN         | MAX   |       | MIN    | MAX |  |
| A   | 24.51       | 25.02 | 0.965 | 0.985  |     |  |
| B   | 9.91        | 10.41 | 0.390 | 0.410  |     |  |
| C   | 6.73        | 7.24  | 0.265 | 0.285  |     |  |
| D   | 4.83        | 5.33  | 0.190 | 0.210  |     |  |
| E   | 2.42        | 2.92  | 0.095 | 0.115  |     |  |
| F   | 5.47        | 5.96  | 0.215 | 0.235  |     |  |
| G   | 18.42       | BSC   | 0.725 | BSC    |     |  |
| H   | 3.94        | 4.44  | 0.155 | 0.175  |     |  |
| J   | 0.10        | 0.15  | 0.004 | 0.006  |     |  |
| K   | 4.95        | 5.21  | 0.195 | 0.205  |     |  |
| L   | 18.80       | 19.55 | 0.740 | 0.770  |     |  |
| M   | 10.54       | 10.80 | 0.415 | 0.425  |     |  |
| N   | 9.91        | 10.16 | 0.390 | 0.400  |     |  |
| P   | 3.05        | 3.42  | 0.120 | 0.135  |     |  |

CASE 333-03

STYLE 1:  
PIN 1. EMITTER  
2. COLLECTOR  
3. EMITTER  
4. BASE



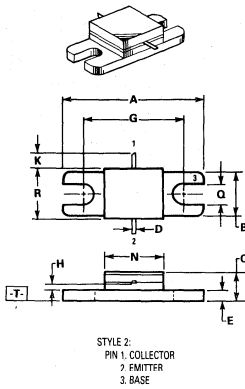
| DIM | MILLIMETERS |       |       | INCHES |     |  |
|-----|-------------|-------|-------|--------|-----|--|
|     | MIN         | MAX   |       | MIN    | MAX |  |
| A   | 24.52       | 25.01 | 0.965 | 0.985  |     |  |
| B   | 9.91        | 10.41 | 0.390 | 0.410  |     |  |
| C   | 6.35        | 7.36  | 0.250 | 0.290  |     |  |
| D   | 1.91        | 2.28  | 0.075 | 0.090  |     |  |
| E   | 2.42        | 2.92  | 0.095 | 0.115  |     |  |
| F   | 2.80        | 3.30  | 0.110 | 0.130  |     |  |
| G   | 3.94        | 4.44  | 0.155 | 0.175  |     |  |
| H   | 0.11        | 0.15  | 0.004 | 0.006  |     |  |
| J   | 2.29        | 2.94  | 0.090 | 0.115  |     |  |
| K   | 18.41       | BSC   | 0.725 | BSC    |     |  |
| L   | 10.55       | 11.04 | 0.415 | 0.435  |     |  |
| M   | 3.05        | 3.42  | 0.120 | 0.135  |     |  |

CASE 333A-02  
(MAAC PAC)

STYLE 1:  
PIN 1. BASE  
2. EMITTER  
3. BASE  
4. BASE  
5. COLLECTOR  
6. BASE

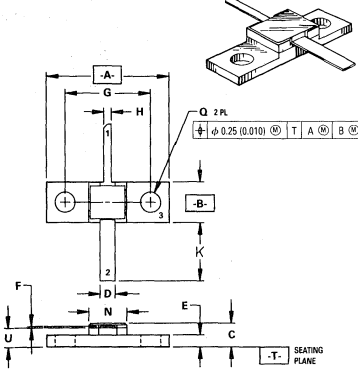
# CASE DIMENSIONS (continued)

3



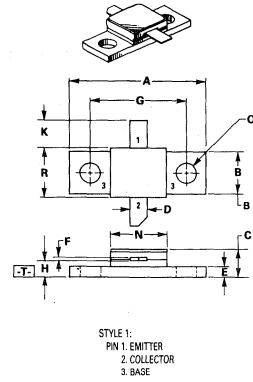
| DIM | MILLIMETERS |       |  | INCHES    |       |  |
|-----|-------------|-------|--|-----------|-------|--|
|     | MIN         | MAX   |  | MIN       | MAX   |  |
| A   | 22.61       | 23.11 |  | 0.890     | 0.910 |  |
| B   | 9.65        | 9.91  |  | 0.380     | 0.390 |  |
| C   | 4.06        | 5.84  |  | 0.160     | 0.230 |  |
| D   | 0.51        | 0.76  |  | 0.020     | 0.030 |  |
| E   | 1.40        | 1.66  |  | 0.055     | 0.065 |  |
| G   | 16.51 BSC   |       |  | 0.650 BSC |       |  |
| H   | 1.14        | 1.77  |  | 0.045     | 0.070 |  |
| K   | 2.54        | —     |  | 0.100     | —     |  |
| N   | 9.91        | 10.41 |  | 0.390     | 0.410 |  |
| Q   | 3.00        | 3.61  |  | 0.118     | 0.142 |  |
| R   | 9.91        | 10.41 |  | 0.390     | 0.410 |  |

CASE 336-03



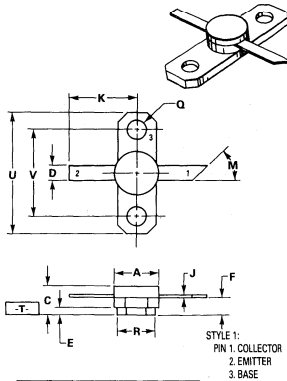
| DIM | MILLIMETERS |       |  | INCHES    |       |  |
|-----|-------------|-------|--|-----------|-------|--|
|     | MIN         | MAX   |  | MIN       | MAX   |  |
| A   | 20.07       | 20.57 |  | 0.790     | 0.810 |  |
| B   | 6.43        | 6.78  |  | 0.253     | 0.267 |  |
| C   | 3.66        | 4.06  |  | 0.144     | 0.160 |  |
| D   | 2.37        | 2.71  |  | 0.093     | 0.107 |  |
| E   | 1.88        | 2.03  |  | 0.074     | 0.080 |  |
| F   | 0.06        | 0.15  |  | 0.002     | 0.006 |  |
| G   | 14.22 BSC   |       |  | 0.560 BSC |       |  |
| H   | 1.10        | 1.44  |  | 0.043     | 0.057 |  |
| K   | 8.79        | 10.10 |  | 0.346     | 0.394 |  |
| N   | 6.18        | 6.52  |  | 0.243     | 0.257 |  |
| Q   | 3.18        | 3.42  |  | 0.125     | 0.135 |  |
| R   | 2.98        | 3.25  |  | 0.117     | 0.129 |  |

CASE 336E-02



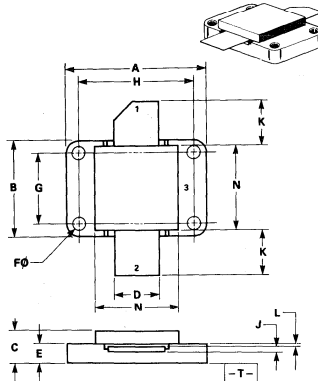
| DIM | MILLIMETERS |       |  | INCHES    |       |  |
|-----|-------------|-------|--|-----------|-------|--|
|     | MIN         | MAX   |  | MIN       | MAX   |  |
| A   | 20.07       | 20.57 |  | 0.790     | 0.810 |  |
| B   | 6.46        | 6.73  |  | 0.255     | 0.265 |  |
| C   | 3.68        | 4.06  |  | 0.145     | 0.160 |  |
| D   | 2.29        | 2.79  |  | 0.090     | 0.110 |  |
| E   | 1.42        | 1.73  |  | 0.056     | 0.068 |  |
| F   | 0.05        | 0.15  |  | 0.002     | 0.006 |  |
| G   | 14.27 BSC   |       |  | 0.560 BSC |       |  |
| H   | 2.29        | 2.79  |  | 0.090     | 0.110 |  |
| K   | 3.43        | 4.19  |  | 0.135     | 0.165 |  |
| N   | 7.87        | 8.38  |  | 0.310     | 0.330 |  |
| Q   | 3.05        | 3.30  |  | 0.120     | 0.130 |  |
| R   | 7.24        | 7.49  |  | 0.285     | 0.295 |  |

CASE 337-02



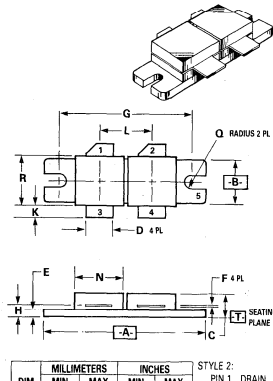
| DIM | MILLIMETERS |       |  | INCHES    |       |  |
|-----|-------------|-------|--|-----------|-------|--|
|     | MIN         | MAX   |  | MIN       | MAX   |  |
| A   | 7.06        | 7.26  |  | 0.278     | 0.286 |  |
| C   | 4.44        | 5.20  |  | 0.175     | 0.205 |  |
| D   | 2.36        | 2.71  |  | 0.093     | 0.107 |  |
| E   | 1.39        | 1.77  |  | 0.055     | 0.070 |  |
| F   | 2.66        | 3.42  |  | 0.105     | 0.135 |  |
| J   | 0.10        | 0.15  |  | 0.004     | 0.006 |  |
| K   | 11.04       | —     |  | 0.435     | —     |  |
| M   | 45° NOM     |       |  | 45° NOM   |       |  |
| Q   | 3.04        | 34.2  |  | 0.120     | 0.135 |  |
| R   | 6.09        | 6.66  |  | 0.240     | 0.260 |  |
| U   | 20.06       | 20.57 |  | 0.790     | 0.810 |  |
| V   | 14.27 BSC   |       |  | 0.562 BSC |       |  |

CASE 361A-01



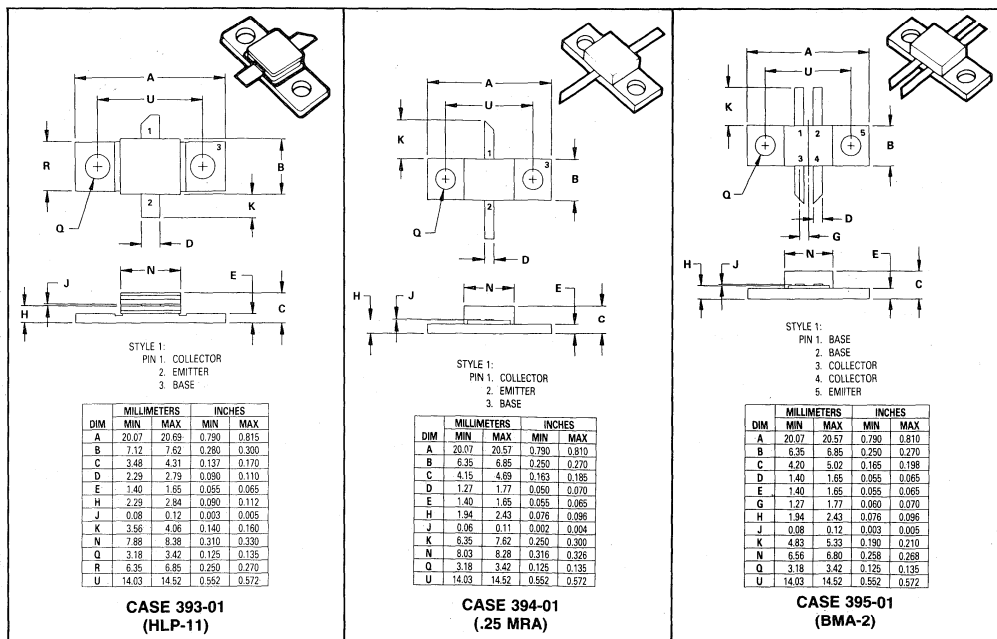
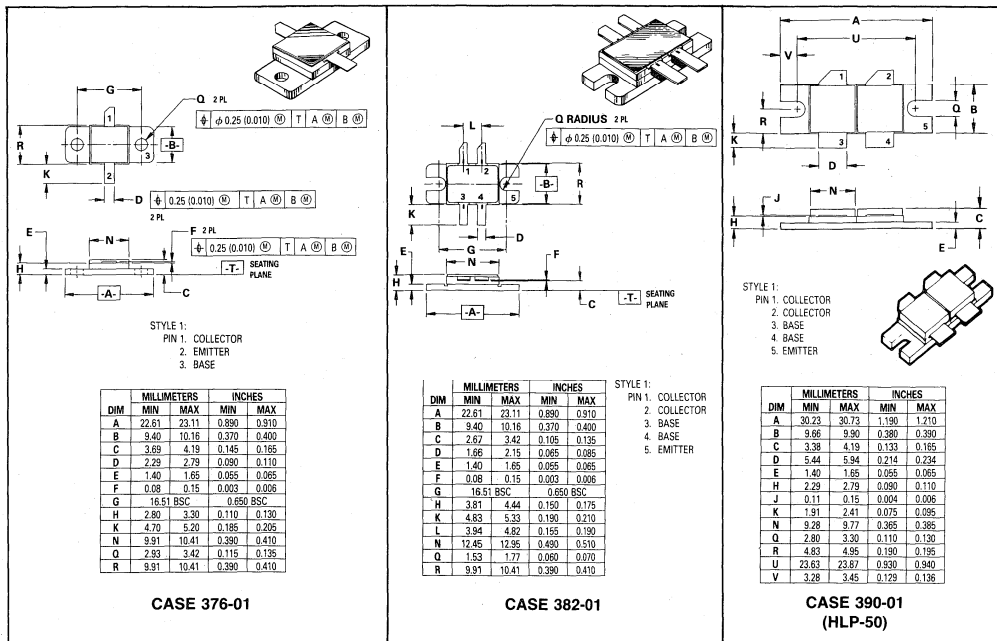
| DIM | MILLIMETERS |       |  | INCHES    |       |  |
|-----|-------------|-------|--|-----------|-------|--|
|     | MIN         | MAX   |  | MIN       | MAX   |  |
| A   | 37.85       | 38.35 |  | 1.490     | 1.510 |  |
| B   | 25.15       | 25.65 |  | 0.990     | 1.010 |  |
| C   | 8.38        | 8.89  |  | 0.330     | 0.350 |  |
| D   | 12.45       | 12.95 |  | 0.490     | 0.510 |  |
| E   | 4.95        | 5.21  |  | 0.195     | 0.205 |  |
| F   | 3.05        | 3.30  |  | 0.120     | 0.130 |  |
| G   | 19.05 BSC   |       |  | 0.750 BSC |       |  |
| H   | 31.75 BSC   |       |  | 1.250 BSC |       |  |
| J   | 1.14        | 1.39  |  | 0.045     | 0.055 |  |
| K   | 10.54       | 11.05 |  | 0.415     | 0.435 |  |
| L   | 0.10        | 0.15  |  | 0.004     | 0.006 |  |
| N   | 22.87       | 23.11 |  | 0.899     | 0.910 |  |

CASE 368-01  
(HOG PAC)



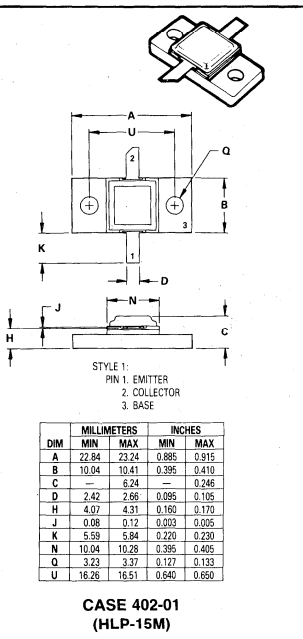
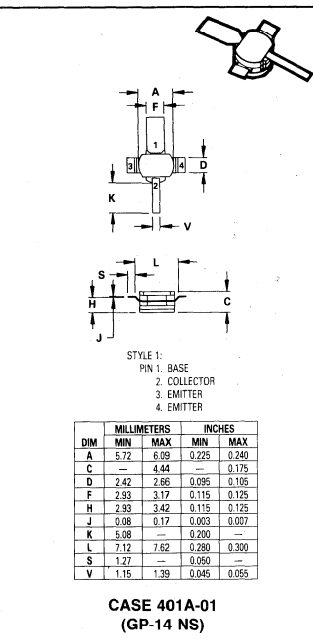
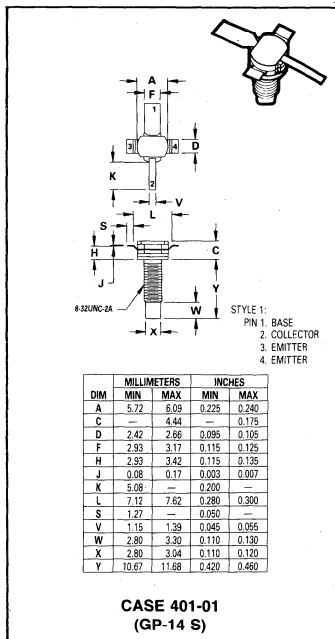
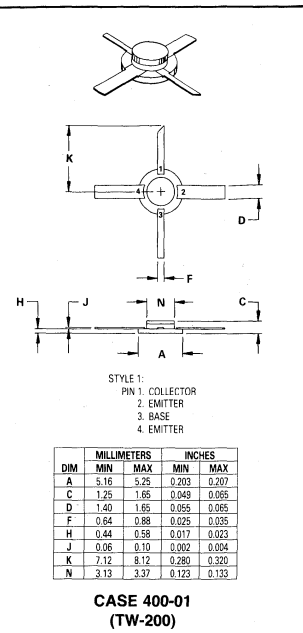
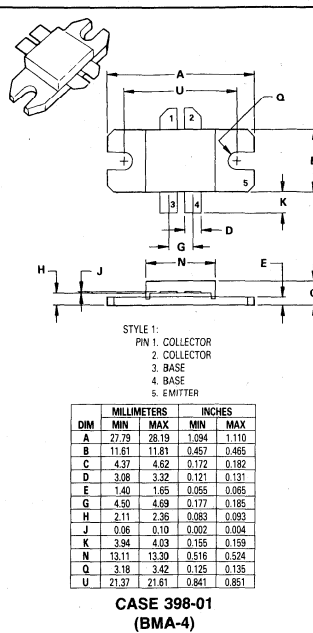
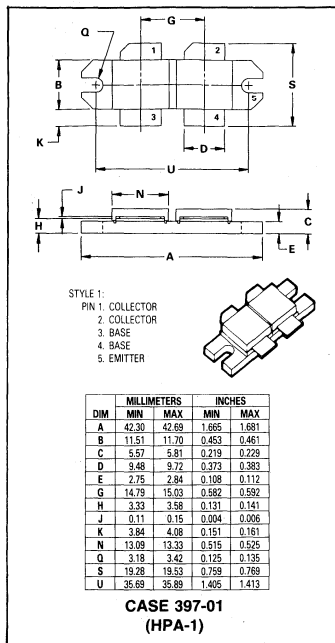
| DIM | MILLIMETERS |       |  | INCHES    |       |  |
|-----|-------------|-------|--|-----------|-------|--|
|     | MIN         | MAX   |  | MIN       | MAX   |  |
| A   | 33.79       | 34.29 |  | 1.330     | 1.350 |  |
| B   | 9.40        | 10.41 |  | 0.370     | 0.410 |  |
| C   | 4.83        | 5.84  |  | 0.190     | 0.230 |  |
| D   | 5.47        | 5.96  |  | 0.215     | 0.235 |  |
| E   | 1.27        | 1.77  |  | 0.050     | 0.070 |  |
| F   | 0.11        | 0.15  |  | 0.004     | 0.006 |  |
| G   | 27.94 BSC   |       |  | 1.100 BSC |       |  |
| H   | 2.29        | 2.92  |  | 0.090     | 0.115 |  |
| K   | 2.29        | 2.79  |  | 0.090     | 0.110 |  |
| L   | 11.05 BSC   |       |  | 0.435 BSC |       |  |
| N   | 10.56       | 11.04 |  | 0.415     | 0.435 |  |
| Q   | 1.35        | 1.67  |  | 0.053     | 0.074 |  |
| R   | 9.91        | 10.41 |  | 0.390     | 0.410 |  |

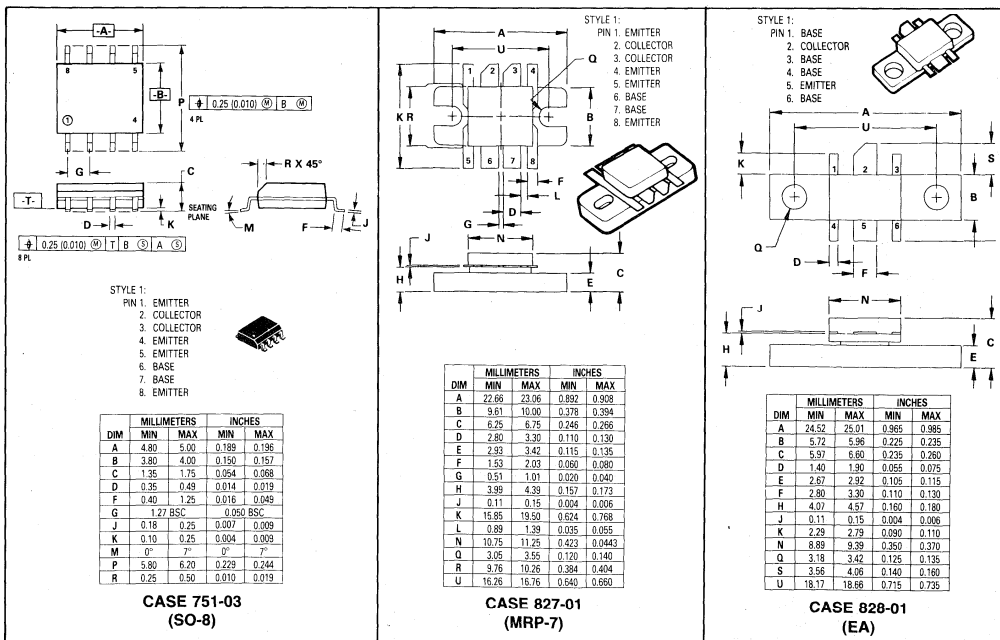
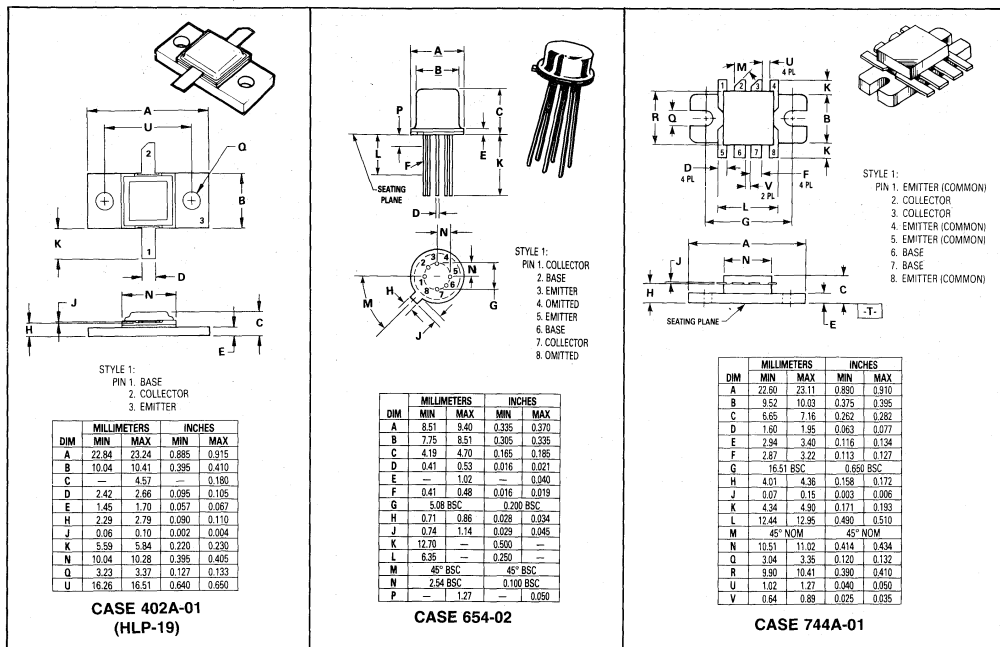
CASE 375-01





# CASE DIMENSIONS (continued)









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Data Sheets**

**3** **Case Dimensions**

## **Volume II**

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**6** **Tuning, Hot Carrier and  
PIN Diode Data Sheets**

**7** **Technical Information**

**8** **Case Dimensions**

**9** **Cross Reference and  
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